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W. T. HARRIS, *Commissioner*

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SANITARY CONDITIONS

FOR

SCHOOLHOUSES

BY

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, D. C., Februarg 21, 1890.

SIR: I have the honor to transmit herewith a manuscript of a circular upon the "Sanitary Condition of Schoolhouses," the preparation of which was procured by Hon. N. H. R. Dawson, lately Commissioner of Education.

The author of the circular is Dr. A. P. Marble, superintendent of the public schools of Worcester, Mass., and during the last year president of the National Education Association of the United States. Dr. Marble is a man of scientific attainments, and has for years made a study of the problem of ventilation, heating, lighting, draining, and schoolhouse construction. The value of the circular will be increased by the addition to it, in the form of an appendix, of a number of designs of school buildings of various sizes, carefully selected with a view to commodiousness, healthfulness, and economy of construction. Among these designs special attention is called to the series of nineteen plates constituting the prize designs selected and published by the State of New York in 1888. The Bureau is indebted to Hon. A. S. Draper, superintendent of public instruction of the State of New York, for permission to republish these designs, and also for the use of the electrotype plates.

The plates of a number of excellent plans have also been kindly loaned to the Bureau by Hon. J. B. Thayer, State superintendent of public instruction of Wisconsin, Mr. Jared Sanford, commissioner of schools of West Chester County, N. Y., Messrs. Isaac D. Smead & Co., Toledo, Ohio, Fuller, Warren & Co., Troy, N. Y., and the Venetian Blind Company, Burlington, Vt.

This circular will be of great use to school authorities, and can not fail to result in improving the quality and condition of schoolhouses throughout the country.

I respectfully recommend its publication at the earliest date possible.

Very respectfully, your obedient servant,

W. T. HARRIS,
Commissioner.

Hon. JOHN W. NOBLE,
Secretary of the Interior.

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[Reproduction of work issued July, 1888, showing designs accepted by the department of public instruction of New York.]

SANITARY CONDITIONS FOR SCHOOLHOUSES.

INTRODUCTION.

Something like seven-eighths of all children under the age of 15 attending school are in the public schools, and the general interest taken in these schools has led to investigations respecting the healthfulness of the surroundings and buildings provided for these children, and the effect of school upon the health and growth of the pupils, and the conditions most favorable to study. For the last 20 years much attention has been given to the proper heating and ventilation of schoolhouses and of other public buildings, and very great improvements have been made. The best systems now in use are incomparably better than those in use only 10 or 12 years ago. As late as 1880, an English work by an eminent writer on school architecture advocated the warming of schoolrooms by open grates and the introduction of fresh air at the bottom of the room and its withdrawal through openings in the ceiling or near it. This method of ventilation is now universally conceded to be defective and objectionable.

The large number of children assembled in schools, the number of hours they spend together at the most impressionable period of their lives, and the necessity for healthy bodily conditions if we would secure good mental growth, all require that the best known provisions be made for their health while in school. Nor should mental growth be of less concern than physical well-being, since both have a direct influence upon morals, which is more important than either.

The subject of sanitation will here be considered under the three heads of—

I.—Ventilation and heating;
II.—Drainage and lavatories;
III.—Lighting.

I.—VENTILATION AND HEATING.

GREAT NEED OF ATTENTION TO THIS SUBJECT.

With all the attention that has been paid to ventilation, the subject has till quite recently been in its infancy, if even now it has attained anything like maturity. This fact is shown in the ill-ventilated and poorly heated halls in all parts of this country and in Europe. It appears in nearly all the costly churches, where the provision for renewal of the air is quite generally wholly insufficient and in a majority of cases not one-twentieth of what it should be. The reason that people are alive and in tolerable health is that they spend only a very small fraction of their time in these halls and churches.

Legislative halls are no better. In many State capitols and municipal council chambers large sums of money have been expended in the attempt to supply the members of these assemblies with fresh air after the buildings have been erected with a view to architectural display and with but little regard to comfort, or the best effects of light, or the proper distribution of heat and the supply of air. But most of these attempts have either failed utterly or have been only partially successful.

Notably the capitol at Washington has been subjected to numerous experiments; but thus far all have proved failures. No hall on the continent, it is probably safe to say, is filled with fouler air than the galleries of the House of Representatives near the close of an afternoon session. A person from the outside world is liable to be made sick by it in 15 minutes, and but few can stand it for more than half an hour without suffering from nausea, headache, and dizziness. And yet $100,000 or more have been expended, first and last, in seeking to remedy this evil.

Many schoolhouses are but little better; and yet most of the children live through it because they go into the open air frequently at recesses, at noon, and morning and night, and the system habituates itself to throwing off the poison inhaled with the vitiated air of the schoolroom, just as a man becomes accustomed to the nicotine poison of tobacco and the alcoholic poison of whisky, and just as the human body has the power of adapting itself to the rigor of an arctic winter, and again to the heat of a torrid summer. The Creator seems to have given us this power of adaptation in order that the race might not become extinct while we are learning how to avail ourselves of the free pure air everywhere supplied. But it will not do to presume too long on this adaptability. The evidences of degeneracy here and there warn us that it is high time to presume no longer.

And in private houses the case is generally even worse than in schoolhouses and public halls. The safety in these houses lies in the fact that but few people generally are confined in one room. It is likely that a very large majority of private houses are heated with stoves, and that in nine-tenths of them no provision whatever is made for changing the air of the room except the occasional opening of a door or a window and the withdrawal of a very small quantity of air through the draft of the stove.

CONDITIONS VARY.

In considering what is the best means for heating and ventilating there are various conditions that must not be lost sight of. A large house heated by a furnace or by indirect steam, with a small family, is one thing. A small house heated by a stove, with a large family, is quite different. In both these the rooms, or a part of them, are occupied through the whole 24 hours. A schoolroom, on the other hand, is occupied only 5 or 6 hours in the day, but it is inhabited by a large number of children during that time. These children moreover are at the period of greatest growth. The tissues of the body are renewed rapidly, and the excretions through the skin and the exhalations from the lungs vitiate the air very rapidly. Furthermore, these children often come from houses not the most scrupulously clean; their clothes are sometimes filled with the odors that arise from cooking, for one room has to serve for kitchen, dining room, and living room. In such a place boiled cabbage, fried onions, or garlic, sausage meat, and doughnuts leave traces of perfume in the dresses of girls and in the jackets of boys. Nor should anyone regard this fact "with a disdainful smile," for out of such surroundings have arisen men and women eminent in the Republic. The fact is emphasized here only to show that schoolrooms where such men and women may be developed ought to have plenty of fresh air.

Difference of climate also is a condition which very much affects the problem of heating and ventilating schoolhouses and dwellings; and an essay designed for all portions of the country, while describing what may be needful for Minnesota and Maine, must be taken with large modifications when applied to the conditions of South Carolina or southern California. But this modification is chiefly one of degree and not a change in principles.

VITIATED AIR.

It is not the purpose here to enter into any scientific discussion of the constituents of foul air, though something of this nature appears below (pp. 43–45). It is rather the purpose to treat the subject in its practical aspects and in a popular way, and yet it is hoped that nothing will appear that is inconsistent with the science of the subject.

Popularly, then, it is said that the air which has been exhaled from the lungs contains a certain larger per cent. of carbonic acid gas, and this gas is known to be heavier than the pure air. It is this gas which settles at the bottom of a certain valley in France to the depth of 2 or 3 feet. Taken into the lungs of an animal it causes death; hence a dog dies when he tries to walk through this valley, because he is immersed in the gas and can breathe no air, while a man walking through with his head above the stratum of carbonic acid gas and in the air, remains uninjured. The danger from this gas arises from the exclusion of air, and not so much from its poisonous nature. It is often asserted that in the process of ventilation the exhaust should be from the bottom of the room because this gas settles there. It is true that the exhaust should be from the bottom of the room, but not for this reason. The foul air of a schoolroom is not always or necessarily at the bottom of the room. It is at the top of the room under certain conditions, and perhaps more frequently than at the bottom. The impurity does not consist of carbonic acid alone; it consists of exhalations from the skin, of other substances thrown off from the lungs besides this gas, and of watery vapor. All this is at a temperature very nearly that of the lungs and the body, which is normally about 98° F., and hence it is lighter than the air of the room, and it tends to rise for that reason. Even the carbonic acid, which in its pure state is heavier than air at the same temperature, being of a higher temperature and mixed with vapor and various impurities, rises to the top of the room at first instead of settling to the floor.

This has been proved by the following experiment: The schoolroom, Fig. 1, was about 40 feet long and 25 or 30 feet wide. It was 10 feet high to the cornice *a*, just above the windows; and above the cornice

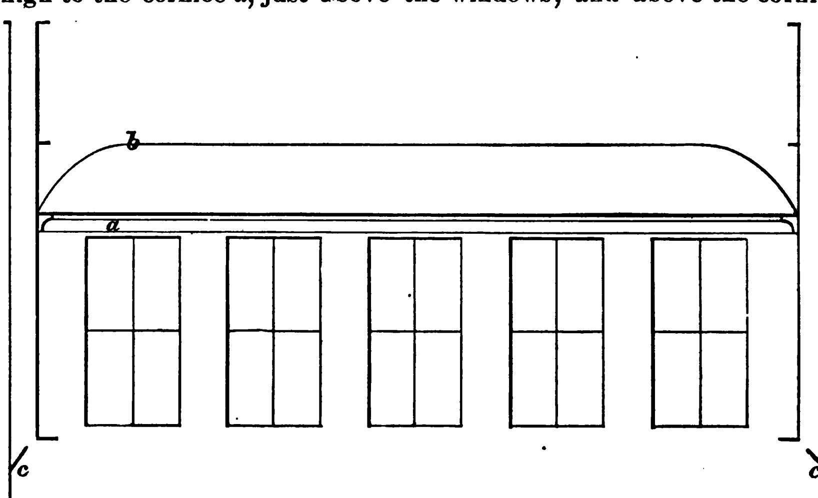

FIG. 1.—School-room.

the ceiling rose in a flat arch 3 or 4 feet to *b*. On the back side were half a dozen windows, on the front side were three doors, and at each end there was a fireplace, *c*, *c*, with a good draft; on the back side of each fireplace, at the end, was a window, and on the front side was a door. The room was heated by a large stove. While the school was in session, the air was admitted from the halls through transoms over the doors, and through the windows, which were lowered an inch or two; and it was exhausted through the fireplaces. The school closed at 1 o'clock, when the windows and doors were thrown open and the wind was allowed to sweep through the room all the afternoon. The room was then as sweet as the out-door air. At night the doors and windows were closed and the fire in the stove was allowed to smolder; but in the morning the room was filled with the school-house odor of foul breaths. At first this seemed unaccountable; but upon careful investigation it appeared that a stratum of warm and impure air had remained in the arch above the cornice, during the afternoon, when the wind had swept through the lower part of the room; and as it cooled at night this foul air had settled and diffused itself throughout the room. The discovery was made by mounting a ladder to hang a picture and putting the head into the stratum of air above the cornice, just before closing the room for the night. This experiment shows beyond a doubt that the foul air will rise to the top of a heated school room, and that this part needs ventilation not less than the bottom.

The conditions in this room would have been vastly improved if the windows had extended to the top of the arch or if there had been a ventilating register at the top of the arch leading into the chimney flue. But the ventilator should have been closed during the day, in this case, or else the heated air of the room would pass out rapidly at the top; and in case the windows were extended to the highest part of the ceiling the warm air would pass out in the same way, unless the openings were barely large enough to supply the air which was exhausted through the fireplaces.*

RADIANT HEAT.

In a small room there is no doubt that an open grate or a wood fire is the best means of heating and ventilation. The heat is by this means radiated directly from the glowing coals; it strikes the funiture, walls, ceiling, and floor of the room and warms them. The air is warmed by contact with these objects and not by the radiant heat passing through it. The air for breathing is therefore comparatively cool, as it ought to be; it retains its natural moisture, and does not absorb from the nostrils, air-passages, and lungs so much of the moisture as to leave them in a dry, parched, and unhealthy condition. The draft of the open fireplace changes the air in the room frequently, and, if the air is supplied through passages around the fireplace connected

* For currents of heated air see Figs. 24–30.

with the outside near the floor and opening near the top of the room above the fireplace, it is partially warmed in passing around the brick work behind the fireplace; and these conditions are nearly perfect.*

But what is so admirable on a small scale is not suited to a large room with many people in it. Too many fireplaces would be required, and in a large building of many rooms the care of these and the inevitable interruption which it would cause, to say nothing of the dust and ashes that would be scattered over the room, all make a great and unnecessary expense. The cost of fuel would also be enormous, for not more than one-eighth of the heat generated by the combustion would be available in the rooms; the other seven-eighths would pass up the chimney.

HEATING BY STOVES.

In a close room the air can be very economically heated by a stove of suitable size. The air is heated by contact with the heated iron of the stove, and its volume being increased by the rarification which heat produces the air immediately rises to the top of the room and is replaced by the denser cold air, and this in turn becomes heated to rise and be replaced by more cold air. It will greatly facilitate this movement of the air, and the consequent heating of all parts of the room, to surround the stove by a jacket of sheet iron raised a few inches from the floor and distant 5 or 6 inches from the stove. The air passes under the jacket and up between it and the stove, and becomes heated in passing. The motion is much more rapid with the jacket, and those pupils who sit nearest the stove are by it relieved from the too great heat directly from the stove. Seats near the stove and those in the farthest part of the room thus become equally comfortable. Such a movement of the air is illustrated by the following diagram (Fig. 2.) of the plan and the vertical section of a round stove with jacket.

A very convenient modification of the jacket is made by constructing a frame of board about 2 feet wide and 3 or 4 feet high, and of slats 2 or 2½ inches wide, with the sides extending 6 or 8 inches below the cross-bars, and a less distance above them. This frame is then covered

* See Circular of Information No. 4, 1880, pp. 78, 79.

with sheet zinc or iron, and two of the frames are hinged together so as to open and shut like a book. When placed near the stove and

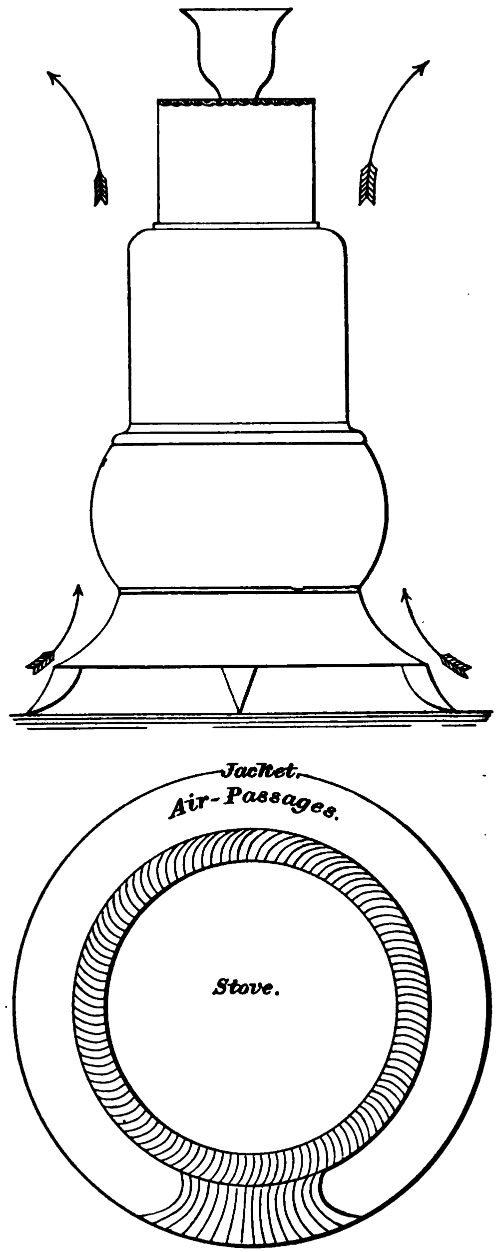

Fig. 2.

opened nearly at a right angle, one of these double frames will serve as a screen; and two of them may be so placed as to serve as a jacket for

the stove. This screen is represented roughly in Fig. 3; of course its size should depend upon the diameter and the height of the stove to be enclosed, and the form may vary to suit the taste.

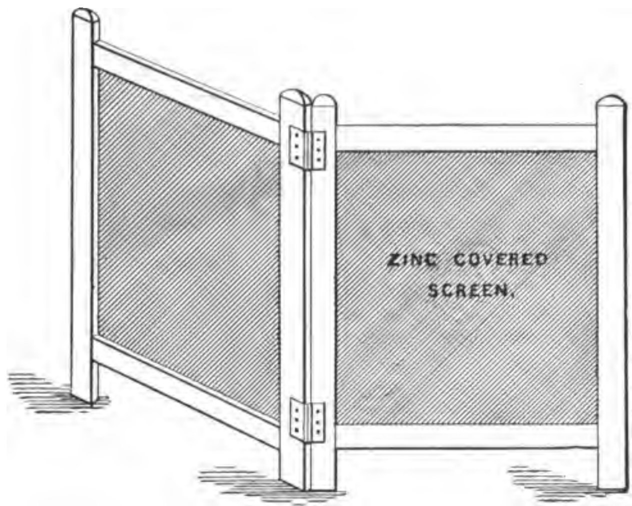

Fig. 3.

There are stoves on the market of various kinds made upon the principle of this jacket; that is, they are inclosed in sheet iron in such a way that the air from the bottom of the room, near the floor, passes up between the heated surface and an outer covering, and is thus made to circulate through the room. While this means of heating is very direct and economical, and well enough adapted to an unoccupied room that is to be heated, such a plan is the worst possible for a room full of children. It does not provide for any renewal of the air; and if the air is admitted through a register or flue at one point in the room, and exhausted at another point, there is this objection, that the air is cold when admitted to the room. If not very carefully arranged, the openings will cause drafts that strike the heads of pupils, since this colder air always tends to fall, as it is presumably colder than the air in the room. If such a stove as is described above is the best to be had, then the fresh air should be admitted at the top of the room. But if the opening is directly through the wall, the tendency will be for the warm air to pass outward, instead of the fresh air passing inward. To obviate this difficulty, the opening outward should be several feet below the top of the room; the flue should be extended upward and open into the room. Such an arrangement allows the passage of air into the room, while the warm air does not tend to pass outward.

This construction is illustrated in Fig. 4, in which *a* represents an opening in the outer wall, which is connected by a flue with the register *b* opening into the room. The heated air which rises to the top of the room will not pass outward through the flue, because it is lighter than the external air; if *a* were directly opposite to *b*, the draft would ordinarily be outward. On the opposite (left) side of the room, *c* represents a register connected with a flue, and if this flue is heated the air from near the floor will be drawn upward and out of the room. If this exhaust is sufficiently rapid, and if the flue is of sufficient size, if also there are several such openings as *a* and *b*, and of sufficient size, the air in the room may be changed with tolerable rapidity. Such ventilation is defective because the air in the room can not be heated by the

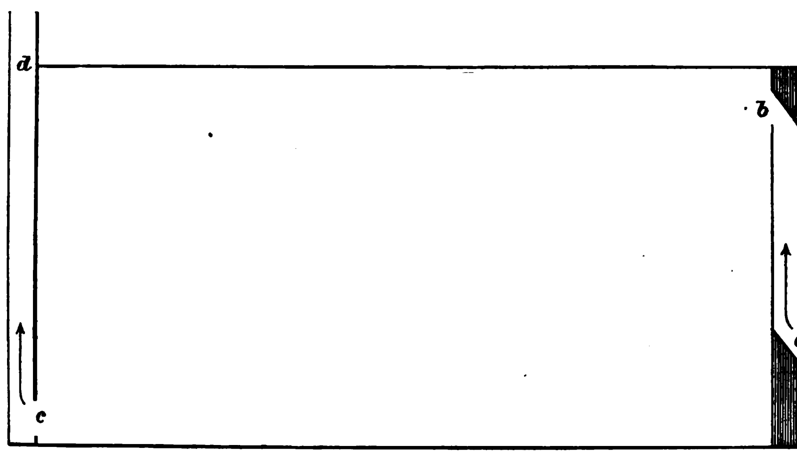

Fig. 4.

stove in cold weather so fast as it should be admitted and exhausted; and some very effective means would be required for heating the flue *c d* in order to secure a sufficiently rapid exhaust. But defective as this plan is, it is vastly better than none, and probably it is much better than anything provided for a great majority of schoolhouses. It has this advantage, that it can be introduced into old houses.

The Eureka ventilator is made to supply fresh air on the principle of the flue *a b* (Fig. 4), and if six or eight of them are inserted on two of the outer walls of an ordinary schoolroom, they will supply an amount of fresh air that will sustain life fairly well. As the air enters through one of these ventilators it has a tendency upward; the air is thus diffused, and it is therefore less liable to strike the heads of the pupils in a cold current. The principle is illustrated in Fig. 5. The slats at *a*, like an ordinary window blind, shed the water in a storm; those at *b* give the incoming air an upward motion, and diffuse it through the room.

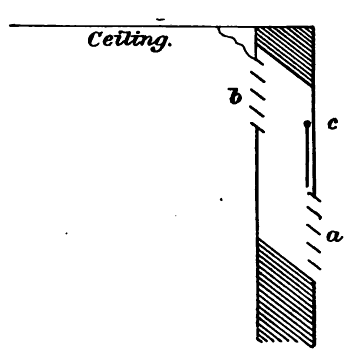

FIG. 5.—Eureka ventilator.

The trapdoor hinged at *c* may be used to close the ventilator; and it is operated by a cord extending into the room and passing over a pulley.

In the absence of even this method of admitting fresh air, a very simple means may be supplied by fitting a piece of board 3 or 4 inches wide, so that it may be placed under the lower sash of a window, and completely close the opening. The raising of this lower sash will leave an open space between the upper and the lower sash, through which the air will enter the room with an upward motion (Fig. 6). Of course, such a simple contrivance will not afford good ventilation; it is simply better than nothing.

With these last two methods for admitting fresh air, and with such a stove as has been described above, the value, such as they have, will depend upon the means of exhausting the air. In cold weather the exhaust should always be from the bottom of the room, close down to the floor. It may be secured through a flue adjoining the smoke-flue of the stove and heated by it. Such a flue ought to have one register near the floor, and another near the ceiling. The latter should be closed, except in warm weather and for a few hours after school. Its use is to remove the vitiated air that may settle at the top of the room, as illustrated in Fig. 1.

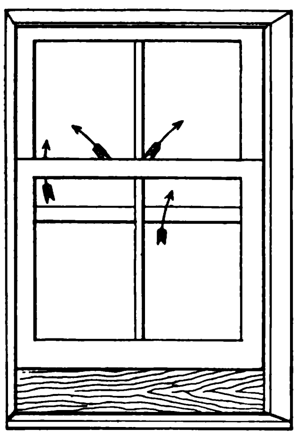

FIG. 6.

A much better method of heating by ordinary stoves is to surround the stove with a jacket extending to the floor, and having a door in front through which to regulate and feed the stove. Beneath the stove an opening may be made in the floor and connected with the outer air, but never with the basement. The fresh air from outside is thus heated as it passes into the room; and if the exhaust is near the stove, and through a flue extending to the floor, the conditions are excellent, provided that the stove, the air supply, and the ventilating flue are of sufficient size. They ought to be about four times as large as is generally thought. Such a stove as is here described is shown in Fig. 7. By closing the ventilating flue and the outer air supply at night, and by opening the door of the jacket, or the lower part of the jacket, the air within the room may be kept warm, when it is unoccupied, with a low fire. In this way the room may be well heated before the pupils enter; but while pupils are in the room the supply and the exhaust of the air should continue.

If the register in the ventilating flue at the top of the room is kept open, then the warm air from the stove will pass up and directly out of the room, as surely as water will flow from a hole in the bottom of a barrel; and the room will be neither heated nor ventilated. This upper register ought always to be closed when the room is to be heated.

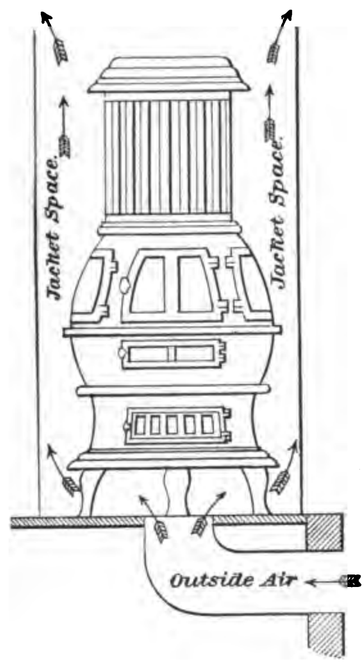

FIG. 7.—Jacket stove.

There are various jacket stoves or heaters in the market that embody the principles outlined above. All these are connected through the floor, at the base, with a flue extending to the outer air; and in this flue the current is regulated by a damper. On the second floor of a house this flue may be carried between the timbers to the outer wall of the house, where the opening should be protected from storms by slats sloping downward, like those of the Eureka ventilator referred to above (p. 15).

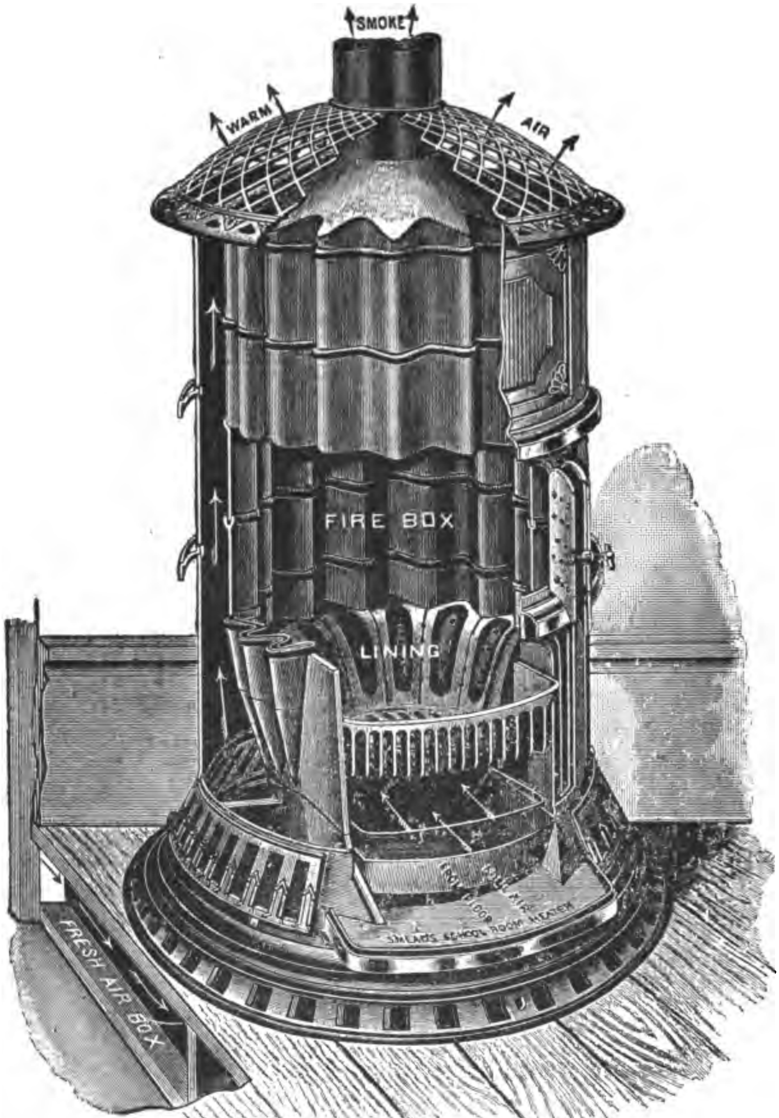

FIG. 8.—Interior view of schoolroom heater.

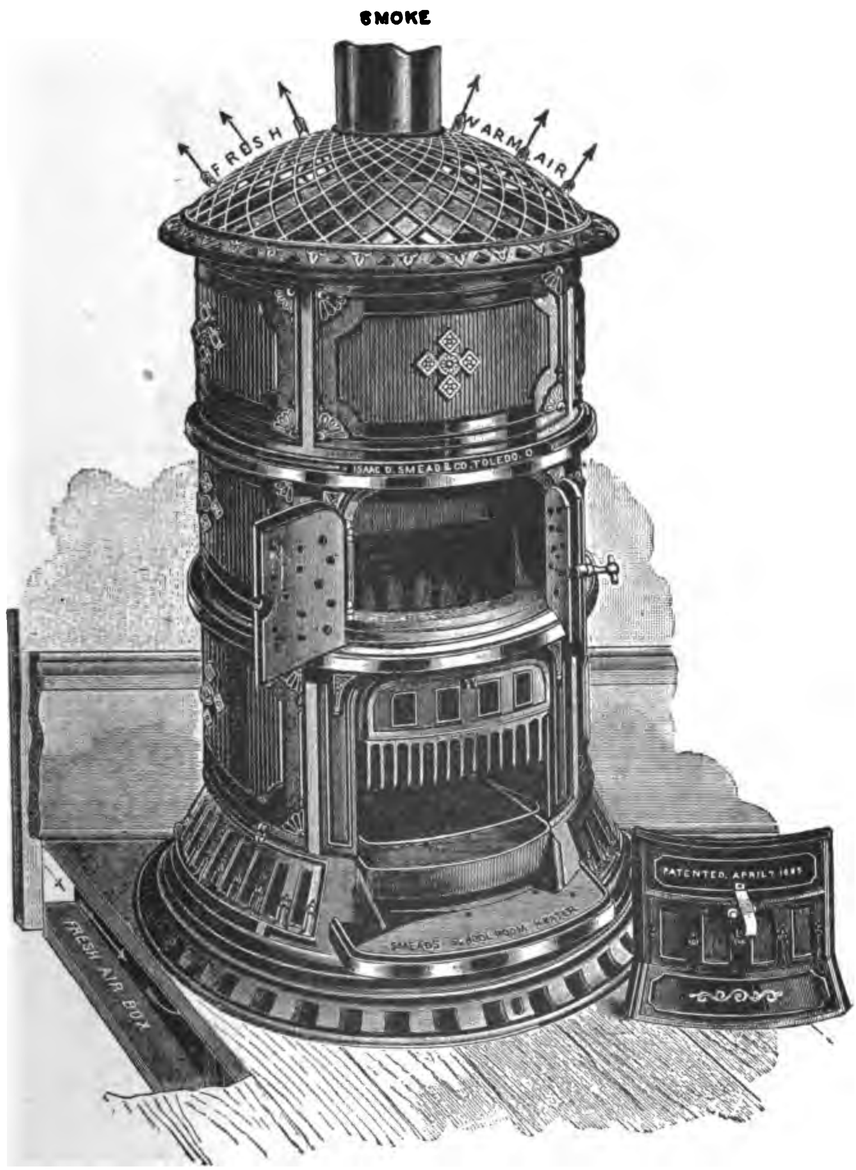

Fig. 8 *a*.—Exterior view of schoolroom heater.


DOUBLE FLANGED
GAS TIGHT STEEL
DOME RADIATOR
DOME
FIRE POT
ASH PIT
SECTION
FULLER & WARREN CO.
TROY N.Y. CHICAGO ILL.
CLEVELAND O.
&
NEW YORK

Fig. 9.

Fig. 10.—The unit schoolroom heater. (Designed especially for hard coal.)

FIG. 10a.—The duplex schoolroom heater. (Designed especially for hard coal.)

This is the latest and one of the best of these ventilating stoves or heaters. It has one, two, or three fire boxes, all or a part of which may be used, according to the temperature. The air may be taken from the outside when the school is in session; or at night and before school, when the air in the room is pure, this air may be passed through the heater and raised to the required temperature. Connected with this heater is a ventilating flue that is heated by the smoke pipe, and by this flue the foul air may be exhausted from the room at the back of the stove and just below where the warm fresh air enters. This secures the most perfect distribution of the heated air throughout the room, as is shown in Fig. 30. The use of this heater does away with the necessity for a separate ventilating flue. It is therefore specially adapted to introduction into houses already built. One large heater may also be used for heating and ventilating two rooms, one above the other. (See, also, Appendix I.)

HOT-AIR FURNACES.

These ventilating or jacket stoves are adapted to small houses with only one or two rooms. Larger buildings may be better and more economically heated by furnaces in the basement. Such a heating apparatus, being in one place or in several places near together, can be more easily cared for by the janitor than several stoves in different rooms and on different floors, and all the noise and confusion in the schoolroom is avoided. The dust, too, which inevitably escapes more or less from any fire, is kept in the basement, and it need not get into the schoolroom at all, as it must where stoves are used.

Heating rooms by hot air has this advantage, that there can be no heat without a change of air; hence there is always ventilation where there is heat. If the room is warm, there is ventilation of necessity.

On the other hand there is an evil attendant upon this means of heating. Unlike radiant heat, it is the air of the room, and not the walls and furniture, that is heated. The air warms the room, and not the room and the fire the air, as where radiant heat is used. (See p. 11.) Moreover, as the air is raised in temperature, its capacity for moisture is increased. It dries the furniture and finish of the room, causing shrinkage and cracks, and it absorbs the moisture from the skin, throat, air-passages, and lungs of the pupils, making them feel parched and dry. This is very unhealthy. It causes diseases of various kinds. This evil has produced a prejudice against hot-air furnaces, but the evil may be easily avoided. It has been caused by the general custom of heating the air too much, and even burning it—charring any impurities contained in the air and destroying the oxygen, which is the life-giving principle of pure air—and by inattention to moistening the air sufficiently.

Usually, in the old furnaces, a small quantity of air has been delivered to the room at a temperature of 150° or 200°, to mix with the cooler air of the room so as to produce the required temperature of 68°; and again, the attempt has frequently been made to send a current of hot air into a room without any means of removing the air already in the room. This attempt is as futile as trying to pour water into a bottle already full. Most rooms are not absolutely tight. There are crevices around the doors and windows and through the walls more or less, and the doors are opened more or less frequently, so that the attempt has not always been entirely unsuccessful; but when the wind blows against the windows and forces itself through the crevices in the walls, the heated air will not rise into the room so situated, and it is impossible to heat it in this way. By connecting a register near the floor of such a room with the bottom of the furnace where cold air is admitted, the cold air in the room will fall to the lower part of the furnace, creating a vacuum in the room, and the heated air from the furnace will then rise to fill and warm the room. The air should never be thus reheated, however, in an occupied room.

In all methods of heating by hot-air furnaces, or by indirect steam or hot water, as much care should be taken to secure the exhaust from the room as is taken to supply the room with fresh warm air. And this is required for the heating alone, as well as for the proper ventilation of the room.

In all methods of this indirect heating, provision should be made for supplying the air with the amount of moisture which it demands in consequence of its higher temperature. This moisture may be supplied by placing a shallow dish of fresh water in such a position that the warm air may pass over it and absorb the moisture. And here great care should be taken to secure the right amount of moisture for the air. If this amount is too little, parched lips and throats, and shrunken furniture will result, as shown above; if the amount of moisture is too great, equally pernicious results will follow. The pupil will breathe an atmosphere saturated with steam; the furniture, ceilings, and the books and apparatus will be injured; and the health of the children will be seriously exposed when they go into the cold outdoor air with their clothing moist, and the pores of their bodies and lungs opened by breathing an atmosphere of steam, more or less perceptible.

In any method of heating, the proper regulating of the moisture is of supreme importance; it is of more importance in using furnaces, because not unfrequently the iron of these furnaces is heated to redness, so that the capacity for moisture of the air is very greatly increased. In heating by hot water the apparatus can never rise to a temperature much above 212°. This danger is, therefore, reduced to a minimum. And in heating by steam the apparatus never rises to so high a degree of heat as it may, and sometimes does, with furnaces.

In respect to steam heat there is a popular fallacy that because steam is apparently moist the air heated by steam must, therefore, be moist. This is an error, because the air is heated only by contact with the iron of the radiators; and this iron is heated by the steam within. Pure steam at a high temperature is dry. Whether or not the steam is dry within the radiators, so long as it is confined within them the air without receives no moisture from the steam. The reason for the popular impression that steam heat is not dry is that quite generally more or less steam escapes from the apparatus. This escape is likely to result in too much moisture; and when this is the case the evil is likely to be greater than if there were too little moisture. It is within the experience of most persons familiar with steam heat that it dries the air and shrinks the furniture. It is equally within their experience, that a leaky radiator will render a room uninhabitable from the presence of steam.

In heating by hot-air furnaces, the radiating surface should be very large; and it should never be heated to redness. The fire should be made to burn slowly, and never be forced. When fresh coal is put on the draft should be left open for a while, and a sufficient amount of air should be admitted above the coal to consume all the gas that is generated by the heat of the burning coal below the fresh coal. The draft should not be closed till all the fresh coal has been burned to redness. It is generally more economical to supply fresh coal often, and in thin layers. This is true of boilers and stoves as well as of furnaces. Not infrequently in passing houses where furnace fires are kept, a perceptible odor of coal gas may be perceived in the street. This is caused by placing a layer of fresh coal upon a hot fire and closing the draft of the furnace. The apparatus is then converted into a gas manufactory; and the gas, which is the most valuable part of the coal for combustion and heat, is driven off and escapes up the chimney without burning, and without producing any heat. All this waste gas could be converted into heat by leaving the draft open till the coal burns to redness, and by admitting a small quantity of air above the coal, as most furnaces, stoves, and fire boxes of boilers have provision for doing.

The air to be heated should be admitted through the basement by openings in the walls on more than one side of the building, in order to avoid the influence of the wind. If the wind blows directly into the cold-air flue, too much air may be forced into the furnace, and through it into the room before becoming sufficiently heated. On the other hand, if the wind is in the opposite direction, not enough air will easily pass into the furnace. If the air is conducted to the furnace from a room in the cellar connected with opposite sides of the building, neither of these difficulties will be experienced. Great care should be taken that the air supply is pure and as free as possible from dust. It should not be taken from near the ground, nor from the vicinity of damp places where any decomposition is going on. It should be conducted to the furnace in an air-tight duct of wood or sheet iron. It is dangerous to conduct the fresh air below the floor of the basement, because stagnant water and decaying substances are liable to get into the duct and contaminate the air. But if it is necessary in any case to conduct the fresh air in this way, the greatest care should be taken to make the duct of brick laid in hydraulic cement and water-tight; and the duct should be easily accessible for inspection at frequent intervals.

The hot-air flues leading from the furnace to the schoolroom should always be vertical, and they should lead directly up from the furnace. The best way is to build them of brick plastered smoothly on the inside, but they may be made of galvanized iron. They should be of ample size, having a section not less than 2 feet square for a room of 40 pupils; and they should enter the room not less than 8 feet above the floor. The opening should be either wholly unobstructed or, at most, screened by an iron frame with wire (not above one-eighth inch), with a mesh of about 2 inches. This opening for the admission of air should be from one-third to one-half higher than its width; and the top of the flues should slope upward to the top of the opening into the room in lobster-back form.

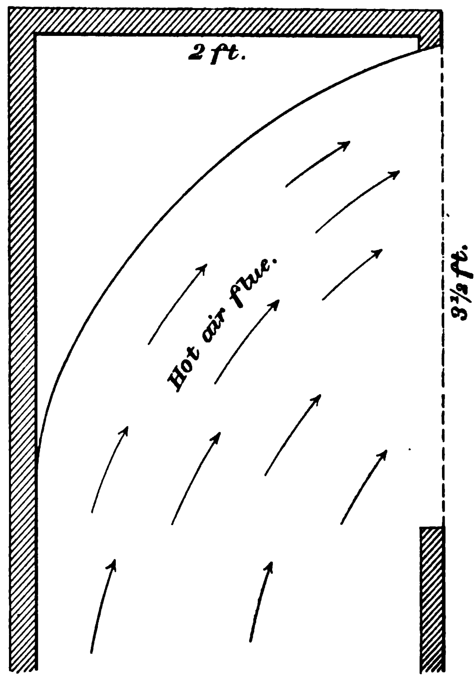

FIG. 11.

The top of the flue (Fig. 11) gives the air an outward direction into the room. The screen (Fig. 12) is so made as to keep things out of the flue and at the same time to obstruct as little as possible the free passage of air. If the flue were left entirely open, not much harm could follow, because of the height; but the opening will look better with the screen. This opening is never to be closed, for when the air entering the room is too hot, by a simple contrivance the hot air is partly or wholly shut off at the furnace, and by the same damper the cold air is admitted through the same flue. Fresh air, either hot or cold, enters the room all the time, and the temperature may be regulated by the teacher at any time. The simple mechanism for producing this result is shown in Fig. 13. While the damper *a* is closed hot air from the furnace passes up the flue; by moving the damper to the position *b*, the hot air is partially shut off and cold air is admitted from the direction *d*; by moving the damper to *c*, only cold air can pass up the flue to the room. This damper is to be operated by the teacher. The hot air rises into the room by its rarity. The cold air is drawn up by the exhaust-ventilation of the room, which is explained below.

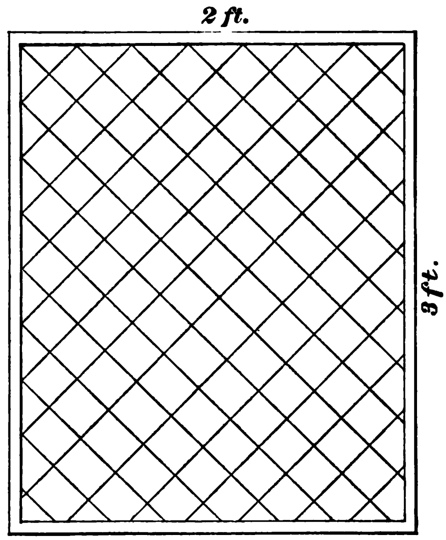

FIG. 12.

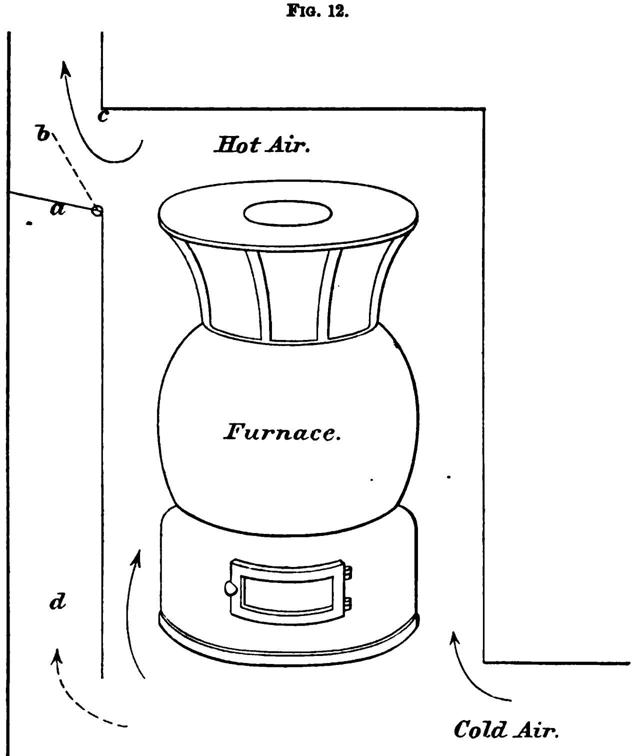

FIG. 13.

There is abundant reason for admitting the warm air from the flue at least 8 feet from the floor. If the air is admitted through a register in the floor, it immediately rises to the top of the room; in passing up it causes a draft or movement of the air in the room, which interferes with the best distribution of the fresh air throughout the room, and which is unpleasant, if not unhealthy, to the pupils near the register; and the air is not admitted so fast as it is through the flue at least 8 feet from the floor, and, worst of all, the dust and smells from dirty shoes over a register in the floor contaminate badly the air entering the room.

THE EXHAUST.

As already stated, the air should ordinarily be exhausted near the floor. It never needs to be exhausted from any other part of the room if the fresh air is admitted near the top of the room as has just been described. In order that the exit may be as rapid as the influx of the air, the exhaust or ventilating flue should be as large as the hot-air flue; and it does not need to be any larger, because the hot air is more rarefied than the colder air, which goes out near the floor. Some means of heating these exhaust or ventilating flues is necessary in order to produce a draft. A compact method of securing this exhaust is illustrated in Fig. 14. Here the furnace is located at the side of the hot-air flues. These flues open at the top of the furnace for the admission of the hot air at 1 1 1 1, and they connect at the bottom with the cold air supply below the furnace at 2 2 2 2. They are provided (at 1) with dampers (*a*, Fig. 13) for mixing the hot air with the cold when desired. The cut (Fig. 14) contemplates the heating of four rooms, on two stories, with the flues between the two rooms. The flue *a* extends to the top of the first-story front room; *a′* to the back room, same story; *b* extends to the top of the front room, second story, and *b′* to the back room on that story. The flue *a* continued to the highest point of the roof serves as a ventilator for the second-story front, and *a′*, extended in the same way, ventilates the back room on that floor. The flue *c* extends from the first floor to the top of the chimney and exhausts the front room, and *c′* exhausts the back room on the same floor. The smoke flue *d* extends from the basement. By this arrangement it will be seen that the smoke flue *d* heats the ventilating flues *c* and *c′* on either side, and causes in them a draft upward, while the ventilating flues *e* and *e′* are heated by the hot-air flues *a* and *a′* below them (the hot air impinging against the sheet-iron bottoms of the flues *e* and *e′*), and by the hot-air flues *b* and *b′* extending up beside them. The flue *e′* is carried to one side, above the hot-air flue *b*, so as to be extended through the roof with the other flues. All these exhaust flues should open into the room at the floor, through passages as little obstructed as the hot-air flues (see Fig. 12). It is better to arrange these openings near the floor, and not more than 6 inches in height. They can often be placed in the rises of the rostrum (when the ventilating flue is behind the teacher), or they may be placed at the bottom of a breastwork in front of the flue, and 3 or 4 inches from the wall. In front of all regis-

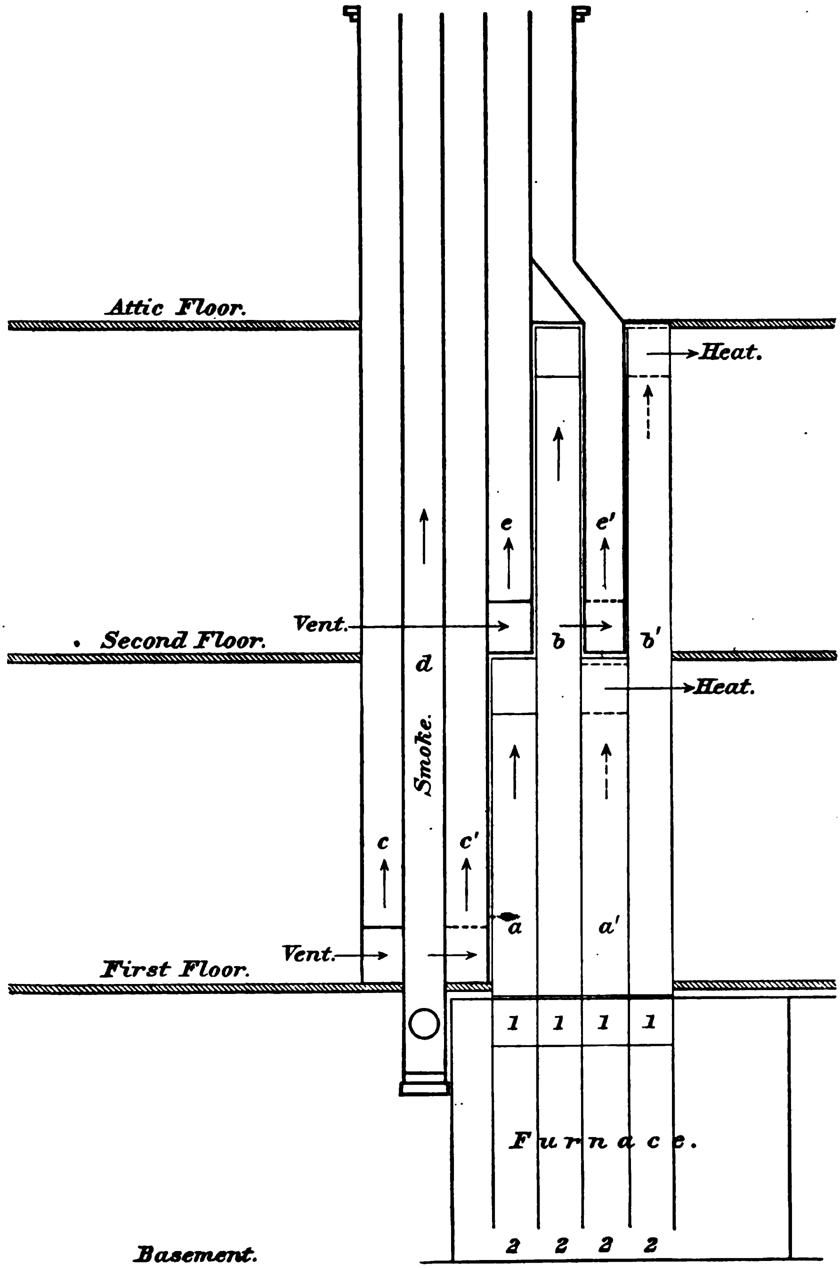

FIG. 14.

ters and windows where they are opened, tack a piece of ribbon 6 inches long to indicate the direction of the current.

Two furnaces may be placed side by side, connected with the same cold air supply, and with one hot-air chamber above. One of these furnaces can then be used in mild weather, and both in very cold weather.

It is to be observed that the longer flues *b* and *b'*, extending to the upper floor, will have a stronger draft than the shorter flues *a* and *a'*; and hence the greater quantity of air would be delivered to the upper rooms. But on the other hand the exhaust flues *e* and *e'*, from these upper rooms, are shorter than the exhaust flues *c* and *c'*, from the lower rooms; and besides, these shorter flues are not heated by the hot-air flues so thoroughly as the flues *c* and *c'* are heated by the smoke flue. As the change of air in the room is effected by both the movement of the incoming air and the exhaust it is probable that the combination of these two forces on the two floors will be about equal. But if this is found not to be the case, the movement of air from the hot air chamber of the furnace up the flues *a a' b b'*, respectively, may easily be regulated at the openings 1 1 1 1.

By the arrangement of the ventilating flues shown in Fig. 15 (plan and elevation), all four are heated by contact with the smoke flue. As all these heating and ventilating flues are in the partition between two rooms, the smoke flue, with the ventilating flues around it, should be placed in the corner of the room, to avoid too many jogs in the partition.

The draft through the ventilating shafts just described, though it may work well in the coldest weather and with a hot fire, is not sufficiently effective in mild weather; and with no fire in the furnace these flues will not draw at all.

A great improvement in the means of exhausting the air from a school-room is described below by reference to Fig. 16. In this case the furnace, as before, is located at the side of the hot-air flues *a a'* and *b b'*. These flues are connected with the hot-air chamber by the openings 1 1 1 1; and these openings are provided, each, with a damper (*a*, Fig. 13) which connects with the cold-air chamber of the furnace at 2 2 2 2. These hot-air flues extend to the top (or nearly so) of the room to be heated, *b* to the second story, front; *b'* to the second story, back; *a* to the first story, front; and *a'* to the first story, back. By the side of the smoke flue *d* a ventilating shaft *d'* extends from the basement to the top of the chimney; and the heat from the smoke flue creates a draft in this shaft when the furnace is heated. In summer the draft is produced by the heater *H*. Connected with this shaft by a brick channel *f*, below the bottom of the flues, are the ventilating flues *e e'* from the second floor, and *c c'* from the first floor—front and back respectively. Each of these has an upright register at the floor obstructed as little as possible (see Fig. 12). The strong draft up the shaft *d'* exhausts the air from the rooms, downward through *e e'* and *c c'*. When the furnace is not fired, a fire in the heater *H* makes a continuous ventilation.

A closely fitting door of tho same dimensions as the horizontal section of the four flues *c c′* and *e e′* may be inserted at the lower end of these two flues, on the front side, next to the furnace. If hinged at

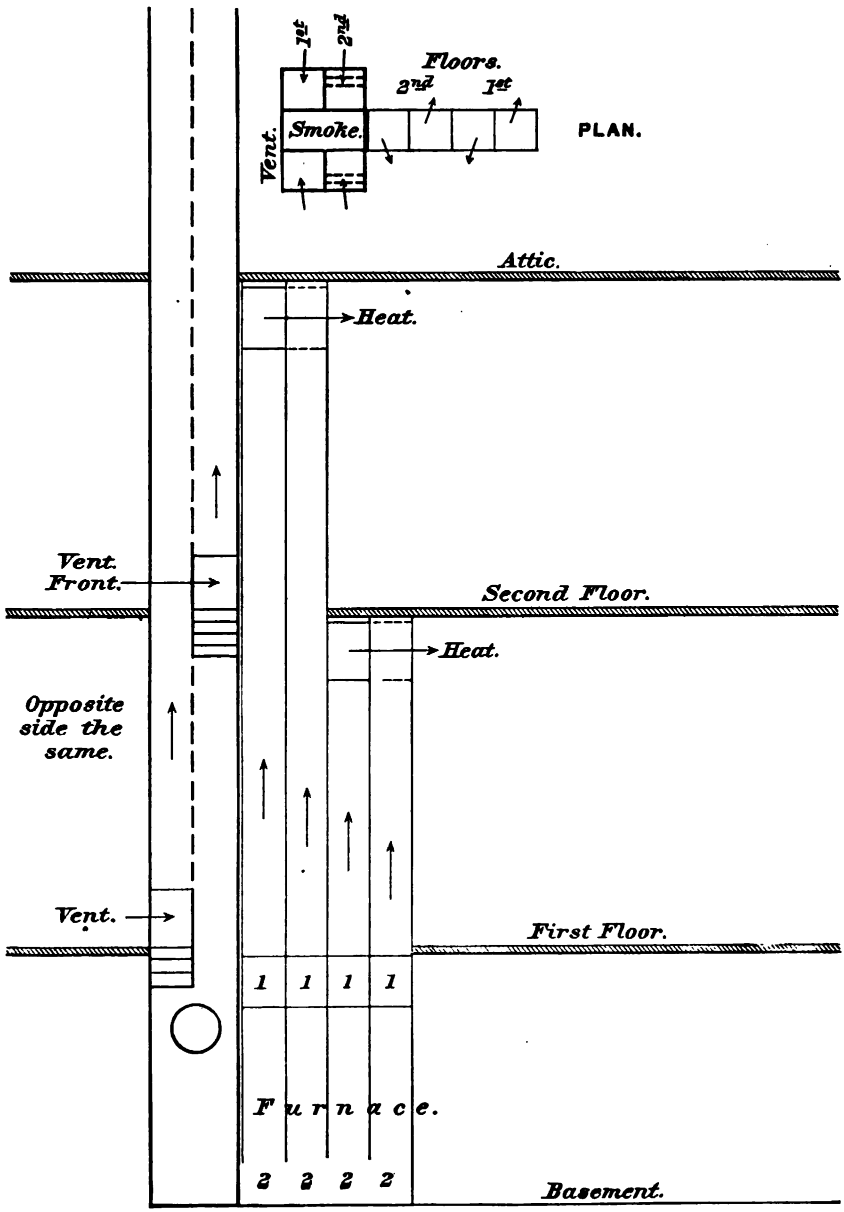

Fig. 15.

the bottom, when opened backward this door will disconnect these flues from tne channel *f* and connect them with the cold-air supply of the furnace. By this means, when the rooms are not in use the air can be drawn from each of them into the furnace through the flues *e e′* and *c c′*, and as it becomes heated it will pass to the rooms again through the flues a a' and b b'. In this case the outer-air supply of the furnace

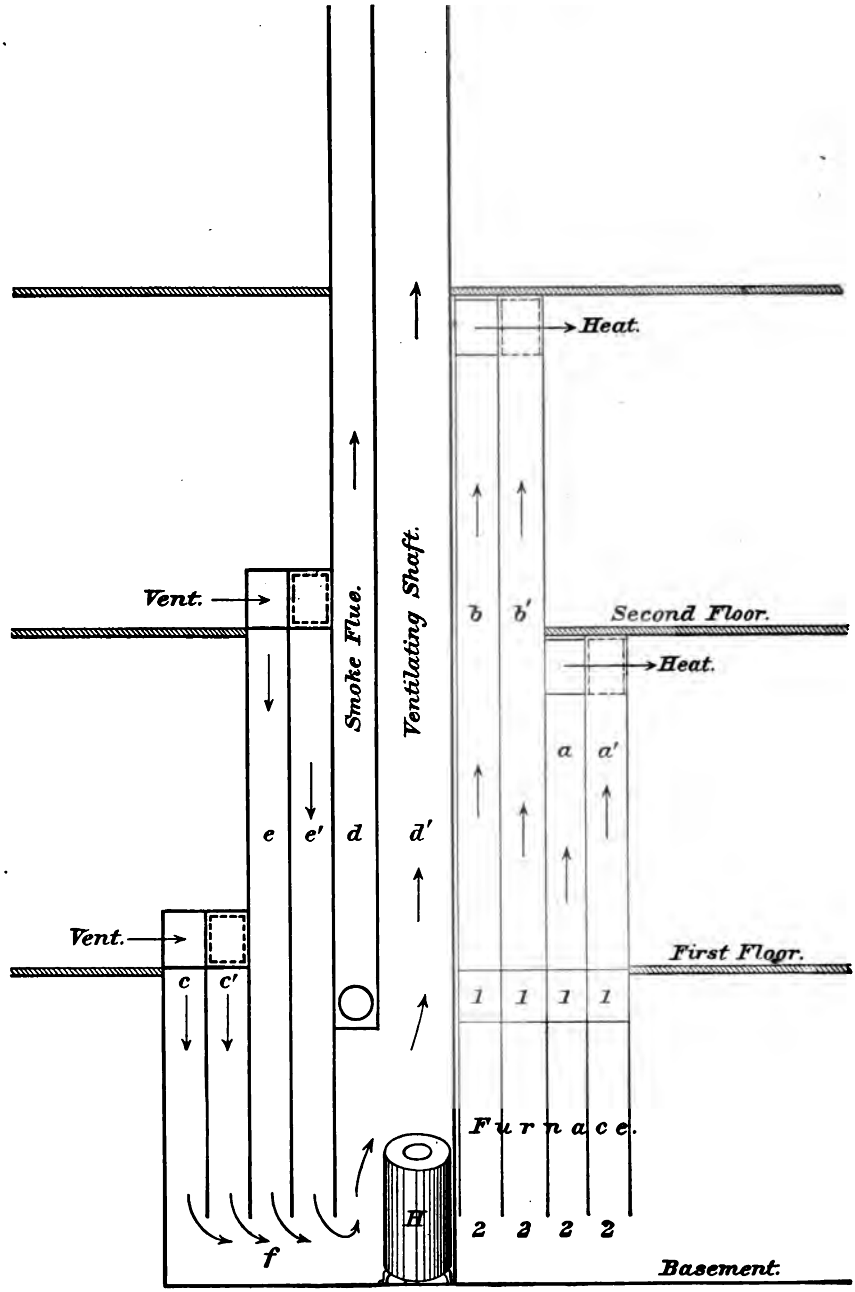

Fig. 16.

would, of course, be shut off. It goes without saying that when the rooms are occupied the air should never be reheated in this way.

Positive ventilation by means of the shaft *d'* and the heater *H*, the ability to reheat the air of the room when this is desirable, and provision for changing the air in mild weather, all show the superiority of this means of exhaust over that previously described. This arrangement of flues is compact; and for heating and ventilating a third story it is only necessary to provide the requisite number of hot-air and ventilating flues. If six rooms are to be heated in this way, a battery of two or even three furnaces may be ranged side by side and one or all may be fired, according to the weather. This downward ventilation may be made useful in another way, which will be referred to in connection with the water-closets, on page 41.

The principle of the downward draft is here thus carefully described, because it is the best way to control the movements of air in schoolhouses of considerable size, by means of the rarefication of the air by heat, and at all seasons ot the year. In practice its introduction has secured the best results attained, and the control of the air currents can be more economically managed in the basement than it could be in the attic of a house. This control is as complete in mild weather as it is in cold.

There is a modification of this downward draft, as set forth above, in the plans of the Toledo schoolhouse (see Figure 37). As there illustrated, the air of the schoolroom is exhausted through openings at the baseboards and beneath the windows. It is then drawn along under the floor to the downward flue. By this means the exhaust from different points on two or more sides of the room distributes the pure air thoroughly; the withdrawal of the air of the room below the floor tends to keep the floor warm; and at the same time the draft across the floor does not strike the feet of the pupils. With this system excellent results have for years been secured at Toledo, Ohio, at Rochester, N. Y., and at many other places. It is to this system that we owe the first application of the principle of the downward draft. The movement of the incoming air by this arrangement is shown in Fig. 30.

But, considering the cost of construction, it is doubtful whether equally good results might not be obtained by placing the exhaust at a single point, at the floor, and as near as practicable beneath the hot-air register, as shown in Fig. 16.

It is a well-established fact in the warming and ventilating of rooms full of people that the air should be raised to a moderate temperature—never more than 100° F.—and admitted in large volumes, through ample flues near the top of the room; and that the exhaust should be from the floor through flues of equal or greater capacity; and, considering economy and compactness of construction, the best way to exhaust the air is through a single flue from each room, as shown in Figs. 16 and 31.

BEST VENTILATION IN A CLOSED ROOM.

But, in order to insure the best ventilation, a room should be tightly built and the doors and windows should be kept closed. If a window, a transom, or a door is left open, the movement of the air necessary to thoroughly ventilate and warm every part of the room will be disturbed, and the desired results will not be attained by any system.

In the cold climate of the Northern States, in winter, the cold glass of the windows chills the air within the room as fast as it comes in contact with the glass. If the air is at 100° and the glass at 0°, a downward current is at once produced; anyone sitting near the window feels this cold current, and usually he thinks that the cold air is blowing in at the window. If such were the case the air would, at least, be fresh and pure; but the air within, which produces the current by being chilled, is not any purer for parting with its heat. In like manner stagnant or filthy water may taste better when in an ice pitcher; but it is filthy none the less.

If one-fourth of the wall space of a room is glass, in zero weather this glass has the same effect upon the air as the same number of square feet of sheets of ice would have. The air simply parts with its heat and falls to the floor. No good ventilation can be had and much fuel is wasted. To obviate this loss and to insure good ventilation, double windows should be provided in all cold climates. The cost of these will be saved in two winters; but, if there were no saving in cost, the increased comfort of pupils would compensate for the extra expense, because the temperature of the room can then be made uniform throughout. And it is a mistake to suppose that double windows are needed only on the north or the west side. The cold winds generally blow from that direction, east of the Rockies, it is true, and hence the windows are needed more on that side; but the air of the room is chilled on a cold day by the glass on the other sides nearly as much as on the north. (See p. 51.)

HOT AIR, STEAM, AND HOT WATER.

Opinions differ as to which is the best of these means of heating a schoolroom. For small houses the hot-air furnace is unquestionably best, provided always that it is of ample size and that it is never heated to redness. It requires less care than steam. By it the room can be heated in a shorter time, and after school there is less waste of fuel. A prime consideration in heating a schoolhouse is that the rooms are used only 5 or 6 hours of the 24. We require a large amount of heat for those few hours and very little for the remaining 18 or 19 hours. With a proper furnace a brisk fire for 2 or 3 hours before school will heat the rooms to 70 degrees, and after the close of school at 3 or 4 o'clock a low fire through the night will keep them sufficiently warm, especially if the ventilating flues are conducted into the cold-air box.

In mild weather also the fires can be kept low and the amount of heat can be easily regulated.

With large buildings, on the other hand, a single large boiler will furnish steam for the whole, and the fire is all in one place. The steam can be conducted to radiators at the bottom of the hot-air flues in any part of the building, and at these points the radiators act each like a hot-air furnace. It is best in all cases to mass these radiators as much as possible, and with flues leading up from them, as in Fig. 16, but in this case it is better to have the radiators for each room in a separate box, and all these boxes connected with the same cold-air supply. A brick chamber, supplied with fresh air like a furnace, may be constructed with flues on the back side opening at the top of the chamber for the hot-air supply and at the bottom connected with the cold air. The damper *a*, Fig. 17, when closed permits the free passage of hot air up the flue and into the schoolroom, and when moved to *b* a part of the hot air is shut off and the cold air from *d* will mix with it. This is the same construction which is shown in Fig. 13 for a furnace. Within this brick chamber a box of galvanized iron is constructed opposite each flue and extending to the top of the chamber; the bottom of the box is a foot or two from the bottom of the chamber, and is made with an adjustable opening for the admission of fresh air. The front of the box is distant from the front of the chamber far enough to allow the janitor to pass along, and this front opens on hinges. Within each of these boxes are two coils of radiating pipes, each with a separate shut-off. It will be seen that in this way one or both coils for each room may be heated, according to the weather, and each room is heated independently of the others.

This construction applies equally to hot-water apparatus if that should be preferred.

Direct radiation by either steam or hot water may do for corridors; a coil may be placed beneath a platform, in a ventilated apartment, for warming the feet. But this means of heating a schoolroom is open to the same objection as the common stove. It may be useful to supplement the indirect heat in the coldest weather, but an additional coil in the box described in Fig. 17 is both better and cheaper for the extra heat. A radiator in the room may be surrounded by a jacket connected with the outer air like the jacket stove, p. 17. But the contact of the cold air is apt to cause snapping of the pipes, so that this device is not advisable.

This snapping of the pipes is a great objection to steam heat, but, when skillfully put in and especially when the coils are dispersed as in Fig. 17, very little trouble will be experienced from this source. The most serious objection to steam heat is the difficulty of regulating it in mild weather, but even here the mixing of the cold air, as in Fig. 17, prevents all trouble in the schoolroom and reduces the difficulty to a mere waste of coal. There is one further objection: no heat is derived from a steam-heating apparatus till after the water in the boiler is raised to 212° and steam begins to form. The remedy is for the janitor to make an early start.

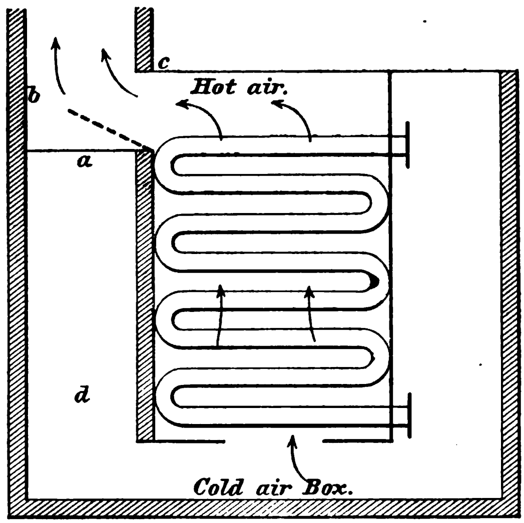

FIG. 17.—End view.

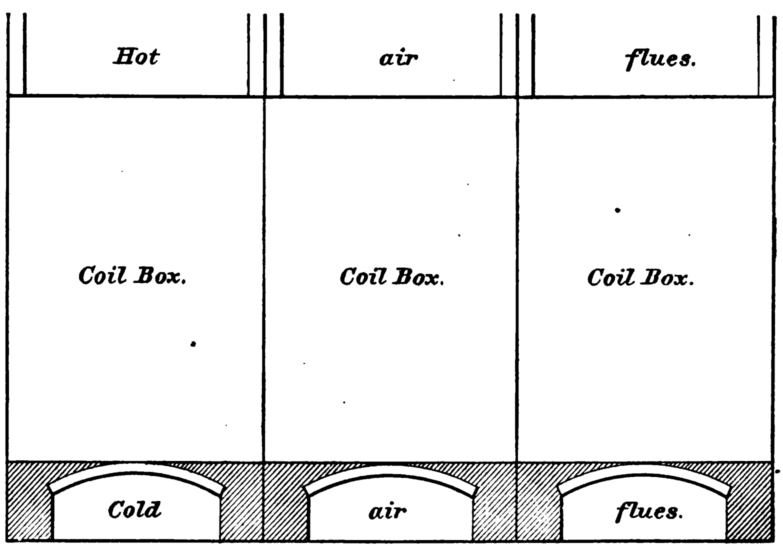

FIG. 18.—Front view.

THE SPACE AND AMOUNT OF AIR PER MINUTE PER PUPIL.

In 1882 a commission of experts was appointed to report upon the school buildings in the District of Columbia. The following are their conclusions:

1. That all sides of the [school] building shall be freely exposed to light and air; for which purpose they shall not be less than 60 feet distant from any opposite building.

2. That not more than three of the floors—*better only two*—shall be occupied for classrooms.

3. That in each classroom not less than 15 square feet of floor area shall be allowed to each pupil.

4. That in each classroom the window space shall not be less than one-fourth of the floor space, and the distance of the desk most remote from the window should not be more than one and one-half times the height of the top of the window from the floor.

5. That the height of the classroom should never exceed 14 feet.

6. That the provisions for ventilation should be such as to provide for each person in a classroom not less than 30 cubic feet of fresh air per minute, which amount must be introduced and thoroughly distributed without creating unpleasant drafts or causing any two parts of the room to differ in temperature more than 2° F. or the maximum temperature to exceed 70° F. The velocity of the incoming air should not exceed 2 feet per second at any point where it is liable to strike on the person.

7. That the heating of the fresh air should be effected by indirect radiation.

8. That all [wardrobes or] closets for containing clothing or wraps should be thoroughly ventilated.

The importance of the last of these recommendations may be noted here for want of a more appropriate place. Both for the comfort of pupils on returning from school, and for the sake of pure air in the schoolrooms, all the wraps, overshoes, hats, caps, and umbrellas, and stockings on stormy days (an extra pair being kept at school for a change), should be deposited in a well-ventilated and heated room. In large buildings a part of the basement may be used for this purpose; and in schools for large children, a small, separate, and well-ventilated closet, about 12 by 18 inches, with a door and lock, should be supplied for each pupil. With smaller children, who need the oversight, or the assistance, of the teacher, the cloakrooms should adjoin the schoolroom. See Figs. 43, 46, 52, 54, 60.

It appears that about 200 cubic feet of air space should be provided for each pupil; the number of square feet of floor space for each should be 15. A schoolroom 30 by 25 by 13 feet would then seat about 40 pupils. For each of these, 30 cubic feet per minute of fresh warm air should be supplied; and the same quantity, of course, should be withdrawn from the room. All the air in the room would be changed in ten minutes. This air should not move at a greater velocity than 2 feet per second, or 120 feet per minute, where it is liable to strike the person. Eight feet or more above the floor it may move with greater velocity, or 200 feet a minute. This requires an opening of about 6 square feet, or 2 by 3 feet; and this opening would discharge easily a vertical flue of 2 by 2 feet, horizontal section (Fig. 11).

In cold weather, when the difference in weight of the warm air and the cold is greatest, this velocity can easily be attained. In mild weather, however, the result is less positive. But in mild weather there is less difficulty about ventilation. The windows may be thrown open on warm days.

But to make this movement of air positive, and to remove all possibility of failure, the air may be moved by a fan, or blower. This can be so constructed that it may either force the air into all the chambers (Fig. 17) from a single fresh-air supply, and deliver the requisite number of cubic feet per minute to each room, or it can be made to pull the air from each room through the exhaust flues or up the shaft as in Fig. 16, if all these flues are connected with a single shaft.

In forcing the air into the room, through the radiators, it is found, first, that disagreeable drafts are caused, and that the air moves too rapidly to the opposite side of the room and along the ceiling; and, secondly, it is found that only about one-half of the warm air delivered to a room goes out through the ventilator. If the fan is used, on the other hand, to pull the air from the room through the exhaust flues, a much smaller quantity of air enters through the warm-air flues than is withdrawn through the exhaust; the balance finds its way into the room, unheated, through the doors and windows.

In order, then, to produce absolute perfection, and to deliver 30 cubic feet of warm air through the flue at the top of the room, and to withdraw an equal amount through the exhaust flue, two fans would have to be used, of equal capacity, and moving on the same shaft, or with uniform velocities; and this construction would not be difficult. But even here there would be this element of uncertainty; that the air from many rooms being withdrawn through a single shaft, more air, at a greater velocity, might be exhausted from one room than from another; and the same difficulty would occur with the warm air. Nothing short of a separate flue for each room, both for the supply and for the exhaust, and a blower in each to deliver and exhaust the required volume of air, would secure this absolute perfection. In addition to this, the temperature of the incoming air would need to be kept at the proper degree by some kind of an automatic regulator. Or, instead of the separate flues and fans for each room, the air could be forced in from one source by a single fan, and exhausted by another through a single shaft, as at first described; and the quantity of air passing through each register might be controlled by a governor placed in the flue and controlling the damper. Such an apparatus would not be difficult to construct.

But it is doubtful whether this supply of air needs to be reduced to so fine a point. With a heated shaft, as shown in Fig. 16, and with heated air from furnaces, as shown in that figure, or from steam coils, as shown in Fig. 17, the results are probably as nearly perfect as this generation is prepared for.*

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* A powerful heater is shown in Figs. 66–71.

The care and expense of the machinery for driving a fan are considerable; the apparatus is liable to break down frequently, and a skilled workman is required to manage it. By a careful estimate of a skilled architect it would require 800 feet of 1¼ inches steam pipe for each box (Fig. 17) to supply 30 cubic feet per minute at 100° for each pupil, in a room of 40, at zero weather, and with 5 pounds of steam pressure.

II.—DRAINAGE AND LAVATORIES.

HOW TO SECURE GOOD DRAINAGE.

Where there is a water supply great danger to health is liable to be caused by imperfect plumbing and sewerage, especially if the closets are in the school building or in the basement, or in an annex connected with the basement. Traps to wash basins are liable to siphon and allow sewer gas to escape into the closets. The best of closet bowls, in a schoolhouse, are liable to become clogged by pieces of paper, apple cores, and other substances which children will throw into them. Urinals especially are frequently a source of disagreeable odors. To avoid exposure it is important that these conveniences should be kept warm, and that they should be reached without going into the open air. The greatest care should therefore be taken, both in their construction and in their daily inspection.

All drain pipes from closets and wash basins should be extended through the roof. All traps should be ventilated so as to be non-siphoning. If closet bowls are used they should be of the simplest construction. Any complicated apparatus is liable, and likely, soon to get out of order. It will not do to trust pupils to flush the closets; and almost any automatic apparatus for flushing them is likely to become inoperative. If such bowls are used they should be flushed at recess by the janitor, or by a constant flow of water during that time; and for the rest of the time of school session, when they are in occasional use, there should be an intermittent flush. The same is true of the ordinary urinals, even the best.

For schools, the Parsons trough water-closet (Figs. 32–35) is better than ordinary bowls, because it is not easily clogged. It is made in sections, and as many sections may be used together as are needed. It should be fitted with separate seats shutting close at the top, and with partitions to keep the closets separate; and each closet should have a door raised 3 or 4 inches from the floor. The space below the seats should be ventilated by connecting it with a shaft having a strong draft, like that in Fig. 16. During recess the water should be turned on; at other times the tank empties itself once in 5 or 10 minutes. The peculiar form of the bottom allows a small quantity of water to stand in each of the sections; and the flow cleans out the trough thoroughly. Beneath and behind the trough there should be no woodwork; the floor should be made of brick or cement, and the back of slate. It is better to have the partitions between the closets also made of slate. There is then no woodwork except the seats, and these should be frequently painted, or oiled if made of hard wood.

THE DRY CLOSET.

In many schoolhouses a system of dry closets, so called, has been in use many years with the most satisfactory results. Where there is no water supply, they are unqualifiedly superior to any rival sanitary appliance; and those most familiar with their working regard them as superior to any kind of water-closets for school use.

In these closets the deposits are dried by the constant passage of a current of air, through the vault and up a heated flue. The construction of the vault being fire-proof, the contents are burned occasionally, or they may be removed if desired.

It is much more economical to conduct the vitiated air of the school rooms from the bottom of the ventilating flues through the dry-closet vaults, and thence up the shaft. The air from the schoolrooms is warmer than the external air; and it therefore dries the excreta more rapidly. The means for doing this is illustrated by Fig. 19. It has been claimed that with such a connection of the vault with the flues from the schoolrooms, there is danger of back-drafts. But in practice this does not occur, as is stated in the extract from the Wisconsin report, Design 12, and in hundreds of places. But if such a danger should be feared, it can easily be guarded against by a shut-off, and by connecting the end of the vault with the outer air. See K in Fig. 19.

Of these closets one writer says:

The theory of dry closets is very simple. The practical application is simple and efficient. Instead of hiding away in pits and sinks—traps and snares for the unwary—or slushing miles of filth into rivers of pollution, and passing it from hand to hand, the giant is to be strangled in its cradle by the constant watchfulness of draft and evaporation.

When every house shall have a shaft to evaporate its filth; when the human brain shall set down to cheapen and render efficient this system, then sewer and vault will be the adjuncts of the drying process.

Another writer says:

These closets are compact, taking up about the same space as water-closets. For closets built in basements, the foundation is a bed of cement, and the walls of the pit for retaining the deposit are of brick laid in cement. The construction is such that in no case can the urine (or any of the contents of the closet) come in contact with any wood surface. All the surfaces exposed are such that no material can be saturated with the moisture; therefore there is at no time any perceptible odor, and when burned out, the pit is as clean as when new. The excrement is deposited on a perforated false bottom, or screen, which allows all moisture to fall to the bottom of the pit. This not only separates the solid from the liquid, but has the additional advantage of presenting three surfaces to the desiccating current of air passing through the closet. In the direct line of the current of air entering the pit, is placed a heater for raising the temperature of the air-current, when the atmosphere is charged with moisture; as on rainy days. In the boy's closets in schoolhouses, or wherever closets are to be used by males only, we provide a ventilated urinal, in which to prevent odors from rising, a constant current of air (which is afterwards used for desiccating the contents of the closet) is passed downward over the metal or stone surface of which the stalls are constructed.

The structure of these closets is shown in Figs. 36–41, and their application in schoolhouses is shown in Figs. 42, 45, 50, and 53.

The greatest difficulty in school sanitation has been experienced with urinals. They need constant and careful attention, or they diffuse foul odors.

The most perfect construction yet noticed is illustrated by Fig. 20. A variation of this construction is shown in Figs. 39 and 40.

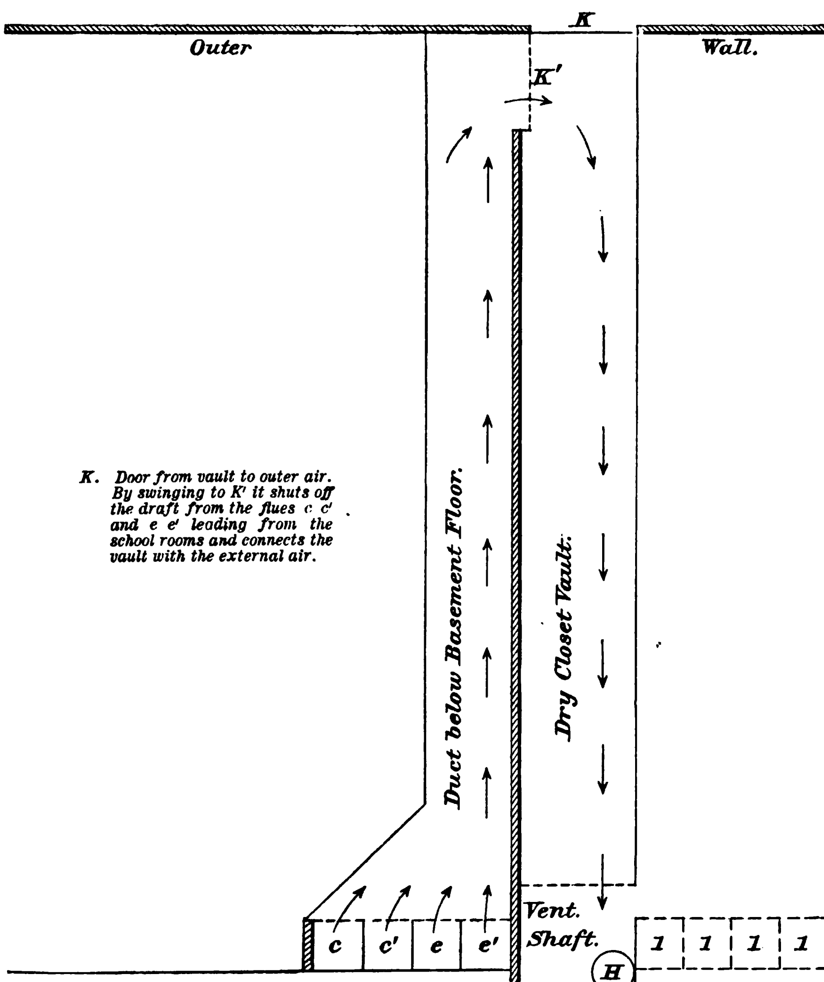


FIG. 19—Plan with Dry-closet Vault.

The floor of both the closets and the urinals should be made of slate or Portland cement. The whole apparatus should be thoroughly washed every day. The superiority of this apparatus consists in its simplicity. There is no wood to become saturated, no place to clog, and nothing to

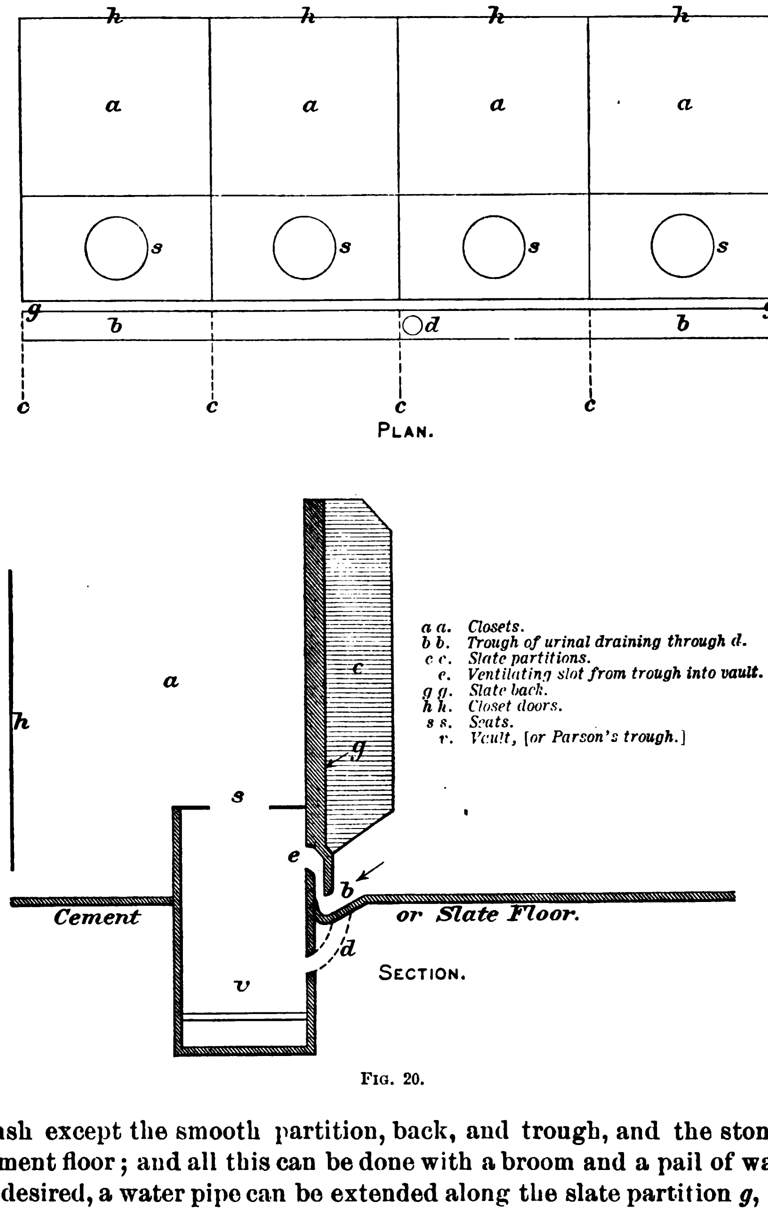


FIG. 20.

wash except the smooth partition, back, and trough, and the stone or cement floor; and all this can be done with a broom and a pail of water. If desired, a water pipe can be extended along the slate partition *g*, perforated so as to sprinkle the whole surface. But the chief reliance must be placed in the daily washing.

This kind of urinal may be used without the dry closet; and in that case the space behind the partition *g* must be connected with the ventilating flue.

In confirmation of many of the suggestions thus far made, and particularly for their inherent value, two reports are here appended.

The following, by Dr. H. M. Quinby, superintendent of the State Lunatic Hospital at Worcester, Mass., was written at the request of the school committee of that city, November, 1888:

Ventilation implies a constant supply of fresh air sufficient for the prompt removal or the proper dilution of any impurities likely to occur in the air we breathe. The amount of air necessary to effect this object varies with the amount and kind of impurities present. In our dwellings the chief source of contamination comes from the processes of respiration and combustion, although if our homes be faulty in construction or neglected, other and still greater impurities may be present as the result of the disintegration and decay which is constantly going on in all organized substances. These latter impurities, however, can readily be guarded against by cleanliness and by the prompt disposal of all effete matter before the process of decay sets in. The question, therefore, which is here presented for solution is one of prevention rather than of removal and belongs to another branch of sanitary science, leaving to ventilation its proper office of protecting us from those constant and unavoidable impurities which result from respiration and bodily exhalations.

Expired air is composed chiefly of watery vapor, carbonic acid (CO_2), and organic matter.

Many regard the carbonic acid as the noxious principle in this compound, but from the fact that atmospheric air with even 2 per cent. of CO_2 added can be breathed without discomfort or injury, it is evident that carbonic acid, unless present in greater quantities than is usually found even in the worst v ntilated apartments, is not injurious to health. It is probable, therefore, that the poisonous agent in expired air must be sought for in the organic matter given off at a high temperature and saturated with moisture—the essentials for rapid decay.

The late investigations of Brown-Sequard and d'Aarsonval go to confirm this theory. They find that the lungs of man, the dog, and the rabbit produce, normally, an extremely active poison which is eliminated continually with the expired air. According to those writers, this substance is apparently an alkaloid, and is probably the principle which renders confined air dangerous.

Absolutely pure air is, undoubtedly, essential for the most complete physical development, but it is nevertheless probable that our systems may become tolerant of a certain amount of impurity, and in this, as in other cases, receive no appreciable injury therefrom, provided the dose be not too great or too often repeated, and especially if it be supplemented by a considerable daily exposure to the outside air.

The question arises, therefore, as to where the danger line begins. Upon this point, the rule laid down by Dr. Parkes in his Manual of Practical Hygiene is the most simple and easily applied. He says, "That, without attempting too much, it may be fairly assumed that the quantity of air supplied to every inhabited room should be great enough to remove all sensible impurity, so that a person coming directly from the external air should perceive no trace of odor or difference between the room and the outside air in point of freshness."

Although the above rule is of great practical utility in determining whether a room is well—or ill—ventilated, it furnishes us no means of measuring the exact amount of impurity present, or of estimating the quantity of air necessary to produce the required degree of freshness.

When we attempt to subject the air of a room to chemical analysis, we find that the processes necessary for estimating the organic matter are long and complicated, and that they seldom insure exact or satisfactory results. The carbonic acid, on the other hand, is easily determined, and although it contributes but little towards vitiating the air we breathe, it bears a constant relation to the organic matter present, and may therefore serve in estimating the more important impurity. Taking the CO_2 as a measure, we find that the organic matter begins to be perceptible to our senses when the carbonic acid of respiration reaches two parts in ten thousand. When 2 per cent. of CO_2 is present, the air becomes exceedingly offensive.

The quantity of carbonic acid which a person exhales, varies with his age, weight, and condition. According to Dr. Parkes's estimate, an adult male in a state of repose, weighing, say, 160 pounds, gives off 0.7 cubic feet of CO_2 per hour; an adult female (120 pounds), 0.6 cubic feet; children (80 pounds), 0.4 cubic feet; amounts which may be largely increased, and even doubled, during active exertion.

If an adult male exhales 0.7 cubic feet of carbonic acid per hour, he should have, according to the above standard, an hourly supply of 3,500 cubic feet of fresh air to replace that vitiated by respiration, and if children exhale 0.4 cubic feet per hour, the supply of air necessary for them would be 2,000 cubic feet.

Some authorities hold that these estimates apply only to apartments which are occupied continuously, and that in schoolrooms, on account of the shortness of the session and the opportunity for frequent ventilation through open windows, this amount may be considerably reduced without endangering the health of the pupils. None of these authorities, however, think it safe to reduce the amount of fresh air below 20 cubic feet per minute. * * *

We do not regard 20 cubic feet of air as providing anything more than tolerable ventilation. There would still be a very sensible amount of impurity in the schoolrooms, and the same care that is now used in assisting ventilation by open windows would still be necessary. Although this amount of air is probably as much as it is possible to provide in old schoolhouses, without too great expense for alterations, it is, in our opinion, much less than is desirable. In all new buildings, provision should be made for a supply of from 25 to 30 cubic feet per minute for each scholar.

Applying the above conclusions to the schoolrooms in question, we find that a room 32 by 32 by 10 feet, containing an average of 40 pupils, would require 48,000 cubic feet of air per hour; that is, that the entire air of the room should be changed every 15 minutes.

At a temperature of 60° and under, air can not be admitted at a greater velocity than 2 feet per second without creating unpleasant drafts. At this rate and temperature it would require 7 square feet of clear opening to supply the required amount of air for the above room, or eight of our common 12 by 18 inch valve registers.

From this, we conclude that all of the methods of ventilation indicated in the circular are alike faulty, and that they differ only in degree. Just how faulty the ventilation is in each case, it is difficult to decide from the data at our disposal; but it is a question whether one-fourth of the amount of air necessary for even fair ventilation is secured when all the available inlets are kept open to the fullest extent that temperature and drafts allow.

It may not be possible to prove in every case that the health of the pupils is injured by such a system, but the fact holds, nevertheless, that there is always great danger from breathing air vitiated by the products of respiration. This danger varies according to the amount of impurities present and the length of exposure. When the exposure is only for a short period, headache, dullness, and slight febrile action may alone result. The cause being removed, these symptoms pass off with greater or less rapidity according to the recuperative powers of the person affected. But when the exposure is frequently repeated, these symptoms become more persistent, and even if no actual disease results therefrom, the whole tone of the scholar's system may be so lowered as to interfere seriously with his physical development, and to render him less capable of throwing off any disease to which he may hereafter be exposed.

It is amply proved by observations upon soldiers in crowded barracks, prisoners in jails, and animals in close and unventilated stables, that when a considerable number of persons are confined for a length of time in close and unventilated apartments, they soon loose color and strength, and become readily susceptible to acute and chronic lung diseases.

The poison resulting from the act of respiration, unlike that of diphtheria and typhoid, acts slowly and presents at the outset no alarming symptoms, nor such as are likely to attract the attention of the casual and untrained observer. In many cases, nevertheless, it is undoubtedly the chief factor in laying the foundation of future lung disease, and especially of consumption.

In regard to question 6 [whether pupils of 6 require the same amount of ventilation as those of 14 years of age], there seems to be a certain diversity of opinion among sanitary writers. De Chaumont, basing his opinion upon the difference in the amount of carbonic acid given off by children of 6 and youths of 15 years, would place three times as many of the former in a given space as of the latter.

Dr. Parkes thinks that children, on account of a more rapid tissue change, exhale more CO_2 in proportion to their weight, than do adults. Dr. Billings would give the same amount of air to all classes. Dr. Lincoln holds that the estimate based upon the difference in the amounts of carbonic acid expired by primary and high school pupils "is admissible only on the supposition that the ventilation is efficient. In case of defect, or apprehended defect, young children should have equal room with older ones, on the ground of their comparative inability to cope with the deleterious effects of bad air." * * *

Where water carriage is impossible, as in the country, or out-lying districts of the city, a vault of some kind is necessary; but in place of a huge receptacle intended to hold a year's deposit, the closet should be so arranged that the fecal matter can readily be disinfected with dry dirt or fine ashes, after each school session, and can be easily removed.

The late Edward S. Philbrick, a distinguished civil engineer of Boston, submitted the following in response to inquiries by the same committee:

FIRST.—THE BEST METHODS OF CONSTRUCTION AND ARRANGEMENT OF FIXTURES.

Plumbing fixtures should in all cases be arranged as compactly as possible. Those which are provided for the convenience of teachers should always be directly over one another on the separate floors, so as to be served by vertical lines of pipes for drainage and water supply. Such fixtures should be placed near but not against the exterior wall of the building, so as to be lighted and aired by a near window in this wall, but not subjected to the exposure to frost incident to being placed against the exterior wall, except on the south side of a building. The water-closets should in all cases have their traps above the floor, and have their water supplied from a small separate tank over each closet. The common "short hopper" patterns are the best for such places, and lead traps are preferable to iron ones, because smoother and cleaner. A separate trap should be provided for each closet, sink, or bowl, and each trap should have an air pipe from near its top, of same size as the wastes for all traps except those serving water-closets, which should not be less than 2 inches in diameter. These air pipes should all be branched into a vertical pipe of 3″ diameter alongside the soil pipe by Y branches, and so arranged as to drain freely, and this vertical air pipe may be branched into the soil pipe by a Y, located above the highest receptacle for drainage and extended through the roof to such a height as will guard against its obstruction by snow. The part passing through the roof should never be less than 4 inches diameter, and should always be left wide open, without bend or cowl of any kind. But if the roof be flat and accessible to children, the end of the pipe may be covered by a wire basket to prevent them from putting stones, etc., into it. If using cast iron soil pipe it should always be of the double thickness, and should be tested for tightness by plugging the outlets and branches and filling with water to the top before applying any fixtures to it. A better class of pipe for public buildings is now made of wrought iron with screw joints, and coated with the Bower-Barff process to prevent rusting, by the Durham House Drainage Company, of Boston.

The water-closets and urinals for the school children should be located in a one-story wing or projection from the basement story of the building, in order to provide the necessary amount of light and air to insure cleanliness. The best pavement is that of Portland cement mortar, which need not be over half an inch in thickness, if spread upon a substratum of concrete 3 or 4 inches thick, composed of American hydraulic cement and gravel, as usually prepared for cellars. The Portland cement may be mixed with three times its bulk of sand, but the latter should be either the best beach sand or well washed to remove dust and clay if from pits or natural deposits. This item of washing the sand will often make all the difference between a durable surface, good for twenty years' service, and a crumbling one, never satisfactory from the first. This skimming of Portland cement mortar should be applied while the foundation is damp, and should be kept damp by sprinkling and exclusion of air drafts for a week after application. Rapid drying by a free circulation of air renders it soft and crumbling, while, if kept wet, it will be as hard as stone in a few weeks.

For water-closets in primary schools the best trough sinks, if properly attended, are probably the safest form of apparatus. The simplest form of seat is the best, but these should be easily removable for cleansing. Boys' urinals should not be provided with crockery bowls, but are better if made of plain upright slate or soapstone, with a trough at the base of the same material, and a sprinkling tube from 3 to 3½ feet above the floor, so constructed as to wet the *whole surface* of the slate below the tube when the water is let on. For children over 12 years of age separate water closets may be desired, but I consider the trough a better piece of apparatus for all classes, if carefully looked after by the attendants. If separate closets are ever used I should avoid all iron as a material in their construction, and use short crockery hoppers with lead traps above the floor. The supply of water should be drawn in this case by a 1¼-inch pipe and 2-inch valve for each closet, from a tank directly above, which can extend the whole length of the range of closets and be fed by an automatic ball cock. Children can never be depended upon to discharge the separate closets, and this has led to various mechanical devices for automatic flushing by wires or chains attached to the doors or seats. In theory these are very good things, but I have never yet seen such devices that could be depended on for many weeks at a time. When they fail they at once create a wretched nuisance, as is now to be seen in some of your schools described below. It is for these reasons that I recommend the trough system for all classes, with thorough and systematic attendance, which is the only way to secure proper flushing in public schools that I have yet seen, and can not be considered as an unreasonable tax upon the attendants.

A system of hoods and air pipes, leading from the water closets and urinals to some aspirating flue for removing the effluvia, has been generally applied in such of your school buildings as I have seen, and with various success. In order to make this system of any real value the aspirating flue should be kept well heated at all seasons of the year by a special stove. I find such an arrangement in some of your buildings. When depending on steam pipes or furnace smoke flues to supply the necessary heat for the aspirating flues, the whole system is sure to fail when most needed, viz, in moderate or warm weather, when there is no wind to remove the effluvia through open windows and when putrefaction is most rapid and the health of pupils more likely to be injured, owing to the general climatic conditions at such seasons. Ordinary summer diarrhea is then often epidemic, and dysentery becomes contagious. The application of these hoods and air pipes leading to flues that are not heated except in winter and even then perhaps insufficiently, as I find in many of your buildings, is, in my opinion, likely to produce more harm than good, for it leads to a sense of security where it does not exist in reality, and may thus take the place of a proper attention to the cleanliness of the floors and walls, troughs, etc., on the part of the attendants.

The apparatus for the ventilation of the schoolrooms themselves next claims our attention. Since the heat supplied for comfort in winter is generally used in our climate as a motive power to secure a change of air in the rooms, the subject of ventilation is inseparably connected with that of heating. This agent may be made sufficient and produce satisfactory results in buildings having but ten or twelve rooms or less, but larger ones may with advantage use fans or blowers to move the air by mechanical force. Since other reasons exist apparently for limiting the size of your school buildings to those containing ten rooms or less, the application of such mechanical apparatus will not now be considered. The heat of the air becomes a motive power by reason of the force of gravity. Hot air is lighter than cold air and floats by its own buoyancy, while the cooler air displaces the lighter by its superior weight. It is generally accepted by physiologists that fresh air should be supplied in schoolrooms when occupied at the rate of at least 40 cubic feet per minute for each occupant. Where a smaller allowance is provided, the pupil suffers a degree of loss of vigor, indicated by sleepiness and stupor and generally impaired vitality. The system of heating by stoves or by direct steam provides no means for introducing fresh air, and is therefore not to be recommended except for halls or passages, or for supplementing in exposed places during severe weather the better system of heating by indirect steam or furnaces. Furnaces serve a good purpose for small buildings, but are not well adapted for larger ones, owing to the difficulty of distributing hot air horizontally, while steam can be supplied from a single fire and distributed for considerable distances.

By the indirect system, so called, the steam is deployed in coils of pipe in the basement underneath the rooms to be heated. These coils are encased by sheet-iron chambers to which air should be conducted by close conduits from the northern and western sides of the building through holes in the basement wall. After being heated by the steam coils the air rises in other conduits to the rooms where heat is needed. As the steam is always as hot as 212° Fahrenheit, and hotter as the pressure is increased in the boiler, a room could be heated to the desired temperature, say 65°, by introducing a small quantity of air heated to 200°, or better by a larger quantity at a lower temperature. The volume of air introduced is regulated by the size of the ducts, and these should be so proportioned as to supply the air in quantity sufficient to meet the requirement above indicated according to the number of pupils to be provided for.

The volume of air in motion should be the same, as nearly as may be, for all conditions of the weather, and the temperature regulated by the amount of steam admitted to the coils and the temperature of the same, which varies with the boiler pressure, and is, therefore, within certain limits, under the control of the fireman. In order to avoid disagreeable drafts within the rooms it is found best to introduce the heated air at a point above the heads of the inmates, say 8 feet above the floor. Its buoyancy carries it directly to the ceiling, wherever the inlet may be, and it spreads around the ceiling and descends along the coldest sides of the room. In order to insure a complete circulation and the continual and successive displacement of all the air in the room, it is best to withdraw the vitiated air from near the floor and on the same side of the room at which the hot air enters. The ducts for removing it should be rather larger than those admitting the fresh warm air in order to avoid drafts near the point of exit, and the upward movement of spent air in the ducts by which it is withdrawn must be helped by artificial means. The method easiest of application for this result is to apply one or more steam pipes within this flue, into which hot steam is admitted, and by which the flue may be heated to a degree considerably above the temperature of the room to add buoyancy to the air as it escapes. It will readily be seen that if the openings for the withdrawal of the spent air are made near the ceiling the fresh air will escape by passing directly from the inlets to the outlets without the entire change of all the air of the room which we seek. Openings for outlets near the ceiling are therefore mischievous in cold weather. * * * They may be of use in summer weather, but are hardly worth providing at this season if the windows extend to a point near the ceiling, as they always should do, and if made to be opened from the top downward.

Thermometers should be supplied in every schoolroom, and the person in charge of the fires should consult them frequently and be governed by their indications.

Sixty-five to sixty-eight degrees Fahrenheit is a proper temperature for schoolrooms in winter. Particular pains should be taken, in proportioning the size of the air ducts, to accomplish the desired movement of air without creating drafts in the room. For this end the ducts should be made of sufficient size to do their work without a more rapid movement at the openings than 6 feet per second. Even a less rate is desirable.

SECOND.—THE PROPER SANITARY CARE OF SCHOOLHOUSES.

Although a good deal of attention has been directed to this subject and a marked improvement made within a few years, much remains to be done, in my opinion, to attain a proper and reasonable standard of purity in all our large cities. Cleanliness is not only of importance in its effect upon the health of the pupils, but as an agent for elevating and civilizing in its influence upon their character. Much more can be taught by example in this respect than by precept. Although the standard now generally maintained in your city, so far as I have opportunity to judge of it, may be above that to which the pupils are accustomed in their own homes in many cases, it is still susceptible of great improvement within the limits of what I consider reasonable and proper.

Modern appliances have brought conveniences under the roofs of our buildings which former generations consigned to outbuildings, and this has been justified by the use of sewers and a copious water supply, by means of which all filth can be at once removed from the premises. Such is the theory of the modern water-closet. In practice, however, it is not always remembered that all the filth should be actually put into the running water. Laxity of discipline exists to a very large extent in this respect in your schoolhouses, due probably to ignorance on the part of the janitors of the importance of a high standard of cleanliness, aggravated by a certain amount of inertia and a tendency to follow old ruts and in some cases also by defective apparatus, of which instances will be pointed out below. Possibly also the force at present employed is not sufficient for the purpose, but I am not in a position to judge of this as well as yourself.

I have spoken above of the need of good light in and around all places of easement. Where a badly lighted cellar is used the janitor readily falls into careless habits. In order to remedy this defect as far as possible at a small cost all the stone and brick walls of the basements should be whitewashed with lime as often as twice a year, and sometimes oftener, where necessary to keep the surfaces bright and pure. The wooden partitions should also be painted a light color, lemon or straw color is preferable, so that soiled places can be readily detected and cleaned and the greatest possible amount of light reflected upon all dark corners. * * *

Portland cement surfaces, as above described, are far preferable on account of the light color of the material. The concrete heretofore used was apparently made with poor materials and crumbles readily, becoming absorbent of filth and difficult to clean. There is but little use in trying to have such floors constructed by contract. The facilities for cheating in providing inferior materials and workmanship are too great to enable any reasonable amount of inspection to guaranty first-class work by contract from the class of men usually dealt with. Poor work in such places is a

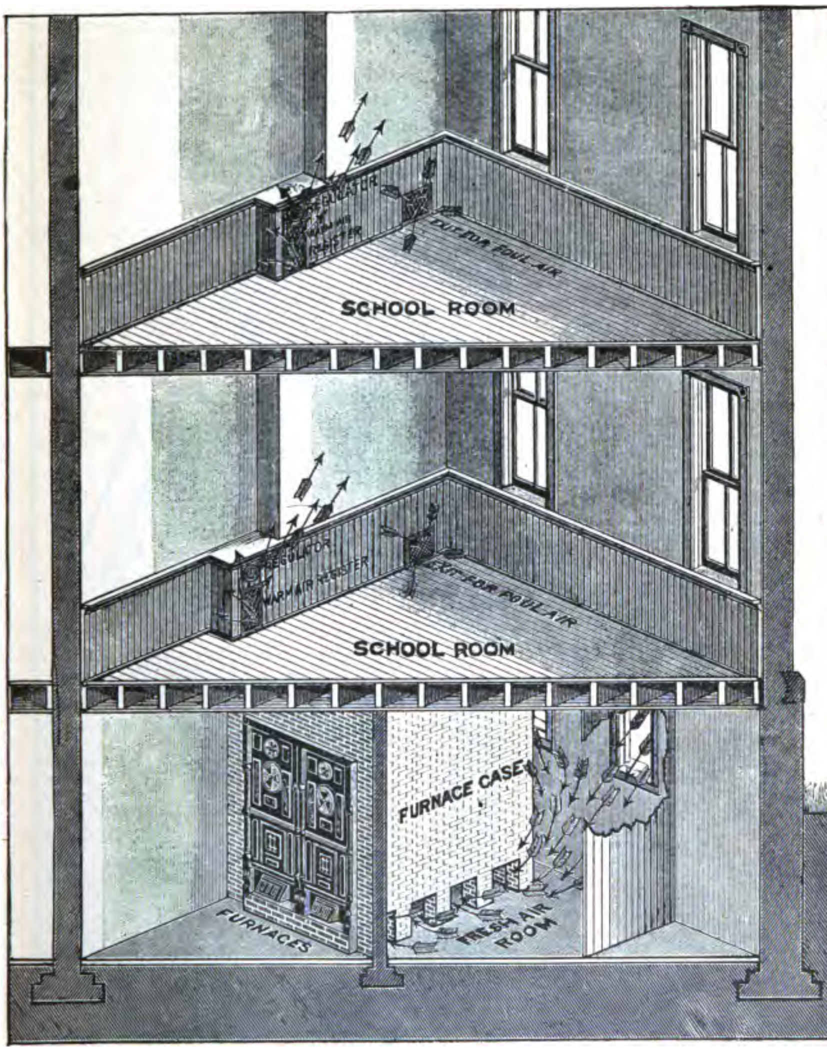
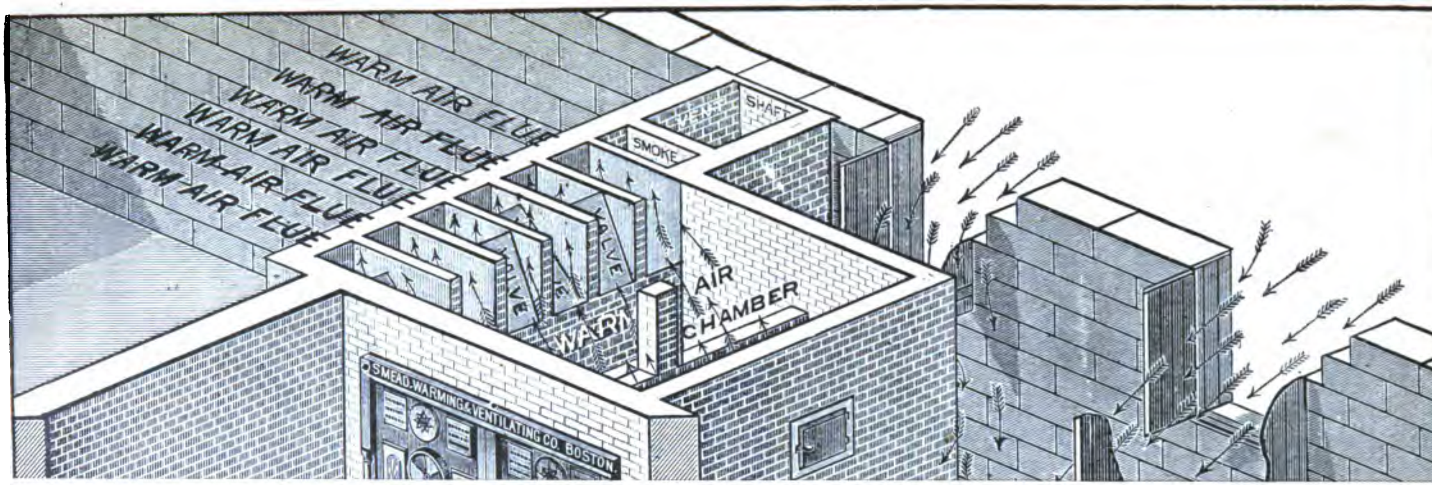


Fig. 31.—Perspective view. Showing air-warmers, cold-air room, and first and second story registers, which should be carried eight feet above the floor on each story.


WARM AIR FLUE
WARM AIR FLUE
WARM AIR FLUE
WARM AIR FLUE
WARM AIR FLUE
WARM AIR FLUE
SMOKE
SHAFT
VALVE
VALVE
AIR
CHAMBER
SMEAD WARMING & VENTILATING CO. BOSTON.

waste of money. Such floors should be laid by day labor, using intelligent supervision, which can be had probably in your case by applying for help from the department of sewers and the city engineer.

All the floors about the water-closets, etc., should be washed by scrubbing brushes daily and rinsed several times daily in hot weather by using the hose, and all woodwork should be carefully washed daily with warm suds where coming in contact with the person or subject to spattering of any kind. In order to avoid too much dampness in the air while the pupils are about, these washings should be performed immediately after school hours, and the proper degree of heat maintained in cold weather to dry the surfaces as soon as possible. The use of carbolic soap is often necessary around urinals, especially when younger boys are accommodated. * * *

The use of the ventilating apparatus is often a subject of great mystery to the teachers as well as the attendants. I found the outlet valves closed in some rooms, apparently from ignorance or inadvertence, and the air consequently very oppressive, while a good draft seemed to exist, able to improve the condition of things materially soon after opening them. I think the use of these fixtures should be explained to all teachers, and they should not be allowed to close them without good reason. If any local reason exists for their disuse, it probably arises from fault of construction which should be remedied. No amount of skill will give us ventilating apparatus that will be at all times successful automatically. If not looked after by persons who understand its uses and abuses, the desired object is seldom attained, except by accident. The flushing of schoolrooms with fresh air by opening windows during recess time and after each session is generally rendered necessary by the imperfection of other means of renewal of air, and it is perhaps better understood than the management of any other apparatus. Unfortunately we have a good deal of weather in winter where this is inconvenient. It may be difficult and perhaps unreasonable to expect the enforcement of such a standard of cleanliness about water-closets in public schools as I have in view while working through the class of men now generally employed as janitors. But I think these men would do excellent work in most cases if clearly informed what is expected of them in detail and if supplied with the necessary assistance to do the actual labor required. This last can not be a severe tax upon the treasury and will be appreciated by the pupils in after life as much, I think, as any part of their instruction received at school. I mean the example of purity which should be constantly before them in these places. The desired result can never be attained till the janitors are not only carefully instructed in *detail*, but industriously *followed up* with military precision and fear of dismissal in case of neglect of duty. Some one must do this duty of inspection who has a real interest in the subject and who will take an honest pride in the result gained, but one person can cover a large number of schools, if inspecting them without notice and if vigilant in his discipline. The janitor's employment should be under his control, to make his work efficient.

III.—LIGHTING.

HOW TO SECURE PROPER LIGHTING.

The proper lighting of a schoolroom is of scarcely less importance than its heating and ventilation and its drainage; for statistics show that diseases of the eye are on the increase among school children, in consequence of poor light.

In Dr. Buk's Treatise on Hygiene, we are assured that short-sightedness, dimness and darkness of sight are increasing generally in Germany, Russia, America, and England [among children attending school], and we are assured at the same time that the defective eyesight is much greater where schoolrooms are poorly planned regarding their window arrangements.

In rural schoolhouses the best authorities seem to agree that the best location for securing light and air is to place the longer axis of the house due east and west, and to light by windows in the north and the south sides only. The objections to the east and the west exposure, for light, are that the slanting rays of the sun, in the morning and in the afternoon, strike across the room. On the south, the sun's rays are always more nearly vertical as they enter the windows; while from the north these rays never in this latitude enter the room.

Next to the north aspect, the steadiest light, as well as the greatest amount of sunshine, is derived from one due south, and while a south window receives the sun nearly all day the year round, the angle at which it enters is so great that the annoyance from it in hot weather is infinitely less than from the horizontal rays which stream through an east or west window [the latter at a low angle]. For this reason a south exposure is both cooler in summer and warmer in winter than an eastern or western one, and while it secures the largest possible aggregate of sunshine, a south window needs less shading with blinds or curtains than any other, except one facing north.

For buildings with four or more rooms on a floor, it is better that the corners of the building stand towards the cardinal points of the compass. It is of course impossible in this case that all the rooms should have the best light; but this arrangement permits the sunlight to enter every room each day of the year; and this is desirable for the chemical effect of the sunlight upon the air of the room. Rooms which the sunlight enters are more easily heated than those that have no direct rays of the sun. They are also both pleasanter and healthier.

It appears to be a well-established rule that the light should be admitted on only one side of a schoolroom, and this side at the left of the pupils. It may be admissible, however, to admit the light partly from behind the pupils and towards their left. It would not be a bad arrangement to have three-quarters of the length of the left wall, towards the rear, and one quarter of the back wall, towards the left, occupied by windows. The main objection to this rear light is that it is directly in the teacher's face, if the teacher sits facing the pupils; but white curtains rolled from the top will prevent a large part of the glare; and the teacher need not always sit facing this light. The windows should be as near together as safe construction will permit; there should be no wall spaces between them. The window space should be one-fourth, and in no case less than one-sixth of the floor space. The windows should extend to the ceiling of the room; and no fancied architectural consideration should ever prevent this. The window sill should be at least 4 feet from the floor; and Robson, the best English authority on the subject, says that the sills should never be less than 5 feet from the floor. The best light is from above; and as this can not easily be had, the nearer we come to that the better. Light from below the pupil's eye, in a schoolroom, is injurious to the eye, and it obstructs rather than aids the vision.

The seats farthest from the windows should not be distant more than one and a half the height of the top of the window. If, then, the room is 13 feet high, the farthest seat may be only 20 feet from the window. For the purposes of lighting, the width of a room should not exeeed 25 feet; and the length should be about one and a third times the width. For its acoustic properties this is a better form than the square, or a shape more nearly a square.

The best light is, of course, that nearest the windows. The outer row of seats, then, should be placed as near the windows as they can be and allow room for an aisle wide enough for a single person to pass. On the side next to the windows the outer row may be placed against the wall, though this is not the best way, on account of the ventilation at the walls. There being no blackboards on this side there is no need of a broad aisle as there is on the back side of the room; and here the importance of double windows is again apparent (see p. 34). Without these, the outer row of seats, having the best light, are most liable to drafts in winter.

The blackboards may be placed at the back end of the room, on the side opposite the windows, and behind the teacher's platform. At this latter point several boards may be made to slide up and down, one in front of the other; or they may be so constructed as to bring into use both sides alternately. In this way exercises may be placed upon the boards and kept out of sight till ready for use. The height of the windows, already described—4 or 5 feet from the floor and reaching to the ceiling—allows the light to strike these boards at such an angle that there is but little liability of that reflection from a much used and shiny blackboard which is so painful and injurious to the eyes. This disagreeable reflection is often caused by low windows, and windows on different sides of the room, which produces cross-lights as well as this reflection from the blackboards.

Strong light is as likely to be injurious as too little light; and on certain days, and with the exposure of a part at least of the rooms of a large house, it is necessary to control the light entering by the windows. This should be accomplished by raising the shades from the bottom of the window. Dark holland shades,* rolling from the bottom and raised by a cord and a pulley at the top, are a better means of regulating the light than the ordinary blinds, either outside or inside. And if the sunlight is liable to strike the books or desks of the pupils, owing to the location of the room, then thin, white holland shades should also be provided, to roll from the top. The purpose of these is not to shut out the light, but to temper and moderate it. The reason for rolling the shades from the bottom is that 1 foot in height at the top of the window lights the room more than twice that space at the bottom; and the best light is that nearest the ceiling.

For the reflection of the light downward upon the desks, the ceiling should always be white. The walls of the room may be tinted, to soften the light; but the tints should not be too dark.

But shades to the windows have these objections: In summer when it is often pleasant to open the windows, they will not allow the air to pass through; they get out of order easily; they become dingy, and need replacing frequently. Outside blinds can not be reached easily from the inside; they do not shade the windows in the right way; on a schoolhouse which is unoccupied three-fourths of the time, they are more apt to get out of order than on a private dwelling. Inside blinds, also, shade the windows at the sides rather than at the top and bottom; or if made with an upper and a lower half moving independently, either one-half, or the whole window, if any, must be closed; and a more serious objection to them is that, with a mass of windows close together, they are in the way, and they obstruct the light.

The best known arrangement for shading windows in schoolrooms is that illustrated in Figs. 21, 22, and 23. These sliding blinds may be raised so as to close any part of the window that may be desired; they allow the air to pass through in summer; they are not in the way, and they may all be lowered so as to leave open the whole window space. In simplicity of construction and operation they are admirably fitted for school use. They can easily be removed for cleaning, and they never need be swiveled. But with these blinds the thin white holland shades to roll from the top may be necessary in some of the rooms, for softening the light.

*The best color is some light shade of lavender, or a mild tint of green. The tints of yellow are not good.

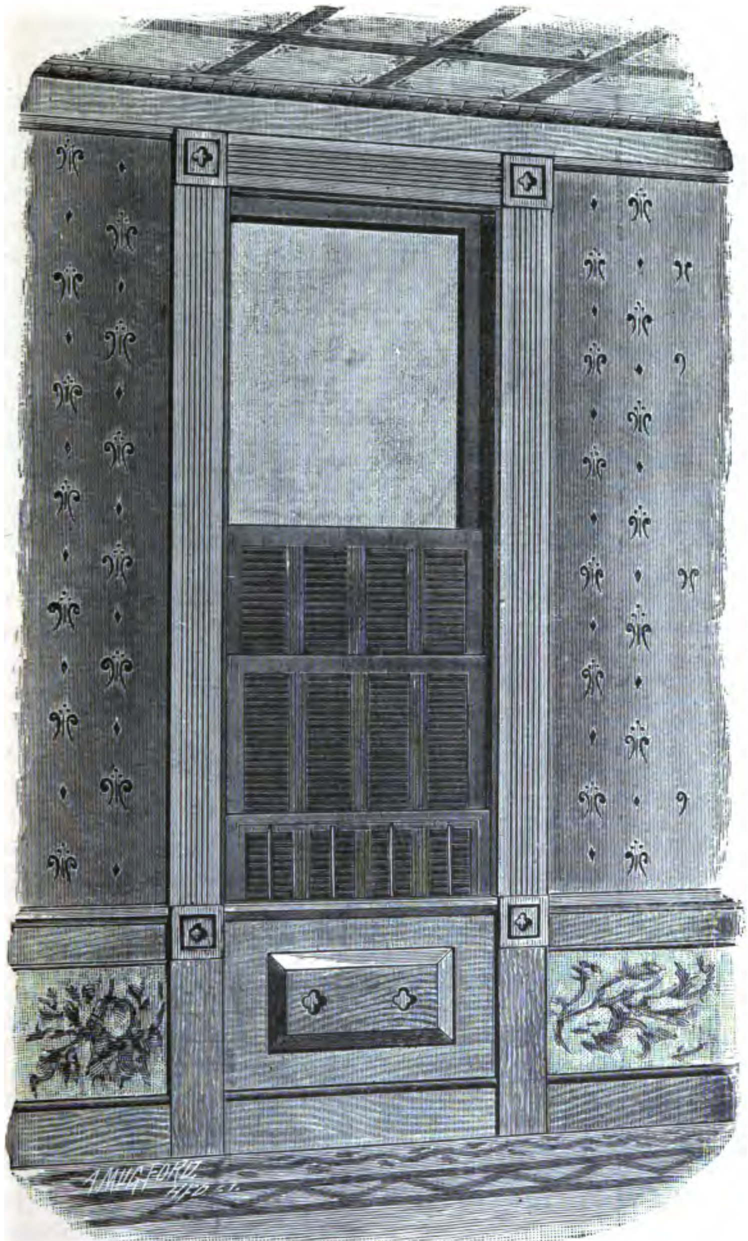


FIG. 21.—The Hill blind, with pocket at bottom of window for a receptacle into which the blinds can be dropped out of sight. When the windows are constructed with slides extending to the floor in front of panel back, the blinds can be dropped, leaving the window entirely exposed. If desired, the outside section can be made with panels, thus forming a neat, inexpensive, and substantial front when blinds are down to the floor.

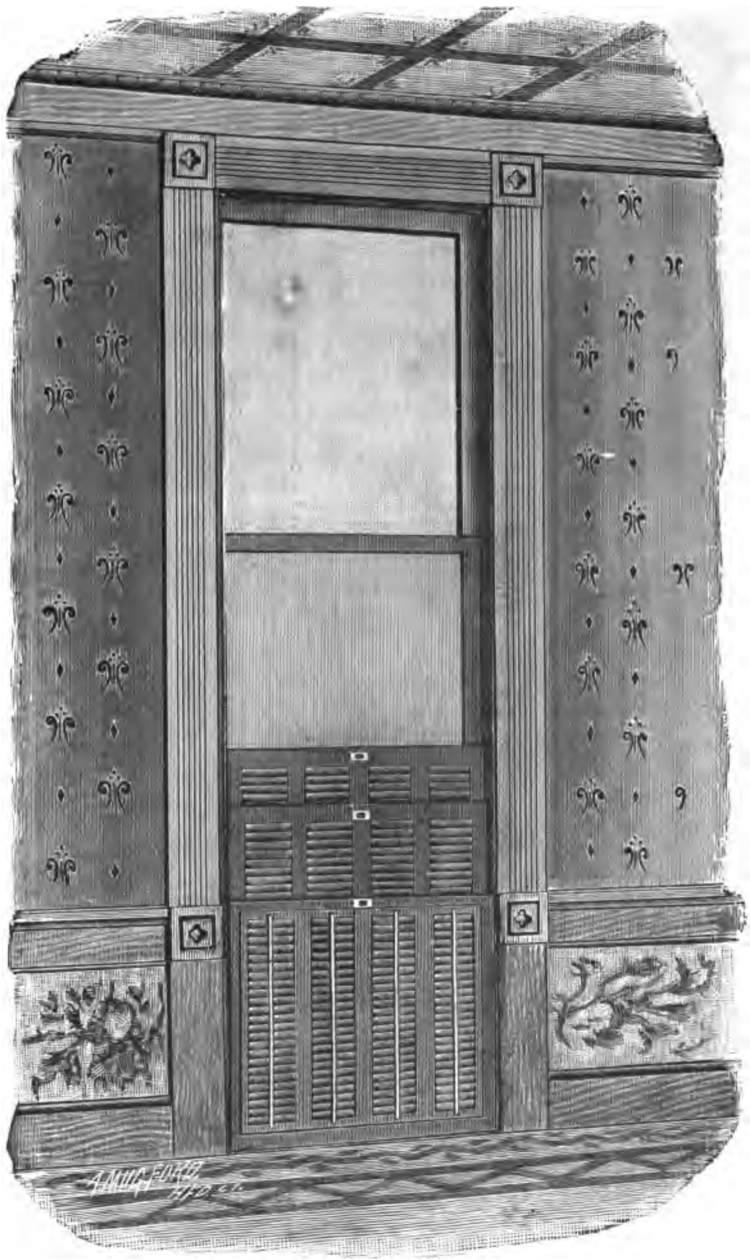


FIG. 22.--The Hill blind in front of panel back at bottom of window, leaving the window entirely exposed.

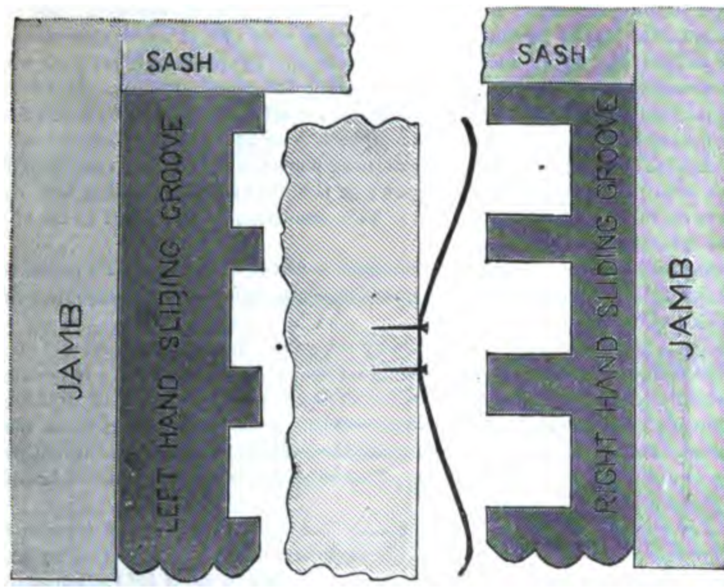


FIG. 23.—This is a full-sized representation of sliding grooves, showing the manner of adjusting them to window frame in place of the sash stop, and a reduced drawing of the friction spring as fastened to right-hand edge of blind.

CARE OF THE EYES.

The following was prepared for the use of the teachers in Worcester, Mass., by Dr. Lewis Dixon, oculist, of Boston. The suggestions are worthy of a wider circulation; and they are therefore inserted here:

Myopia,

Or near sight, is not often congenital but it is usually acquired. It is due to elongation or bulging of the normal spherical eyeball from before, backward; this carries the retina away from the focus. Myopia is chiefly caused by near work, too long continued, and under wrong conditions, assisted often by hereditary tendencies. Near work *causes* and *increases* the myopia but does not usually cause pain or fatigue. Myopia is detected by the inability to read letters of one-third inch square at 20 feet distance, or fine type at 10 inches, through a 10-inch lens. To prevent or check the condition, advise the child to hold head and work up and hold the work well off; to rest frequently for a few minutes, by either closing the eyes or looking at a distance; also, to avoid unnecessary near work both at home and in school as much as possible. If the myopia is greater than one-thirty-sixth, glasses should be worn constantly. If myopia shows a tendency towards rapid increase, especially after illness, advise complete cessation from *all* near work for awhile. In testing for myopia, strive to make it as small in degree as possible, and *doubt* its presence in slight degrees till proved by repeated tests, for the eye often simulates myopia when tired. In hypermetropia the eyeball is congenitally *too short* from before, backward, the retina being in front of the proper focus. This condition is a fixed one, getting neither better nor worse, but it *necessitates* under *every* ordinary condition *more* than the proper amount of work on the part of the muscles of accommodation, and also *necessitates constant* (and therefore very fatiguing) instead of the normal *intermittent* work. Vision is perfectly *good* under all tests; but it is so at the expense of *constant* but *unconscious* effort, The symptoms are fatigue in some form, following use of the eyes; not necessarily felt *in* the eyes; headache, pain over the eyes, blurring, nervousness, and inability to continue school work through the term. In this condition, near work is too burdensome to be continued without overtaxing the nervous system. It is detected by the inability to read 20-foot letters at 20 feet, even when assisted by a convex 36-inch lens; or by reading fine type through a 10-inch lens at a greater distance than 10 inches. Advise sparing use of the eyes on near work; frequent rests and avoidance of studies requiring much fine close work; or the use of glasses which will enable the eyes to do full work *without* fatigue. This condition is the usual cause of strabismus or crossed eyes.

In testing for hypermetropia always *endeavor to find it,* and suspect its presence till repeated tests show its absence, in all cases where the child has headache, tires easily, or complains of blurring.

Astigmatism is the result of a congenitally irregular (instead of spherical) cornea; all sight is fatiguing to such an eye, but close work particularly so. It is detected by the child's tendency to miscall letters and figures, by squinting or holding the head sideways to see clearly, or by seeing some of a set of radiating lines blacker than others. Nothing can be done but spare the eyes from near work, unless glasses are made to order, to correct the errors. This condition is also the cause of headache, pain, nervousness, and ill health.

Glasses for hypermetropia and myopia may be roughly but safely determined and advised for those unable to have a more accurate test made. This is done by finding the difference between one-tenth and the fraction represented by 1 divided by the *greatest possible* number of inches at which the child can be made to read fine print through the 10 inch lens.

For example, if he reads at 8 inches, and never farther off, we have 1-8—1-10=1-40. The denominator 40 shows the focal power of the glass needed, and the point of reading being *nearer* than the normal (10 inches) he is near sighted, and needs concave 40 glasses.

If 15 inches is the distance that the child can read through the 10-inch lens, then 1-10—1-15=1-30, and he needs a 30-inch glass to correct his error; *convex* because he reads farther off than the normal 10 inches. So if 6 inches is the point, 1-6—1-10= 1-15, and concave 15 is the glass needed. If the point is 20 inches, then 1-10—1-20= 1-20, and convex 20 is the glass. Remember to make the *concave* glasses always as *weak* as you can and the *convex* glasses as *strong* as you can.

Warn children and parents that in myopia the tendency is towards increase of the trouble, and that care in regulating the amount of near work will do much to check the progress, and the wearing of glasses, if myopia is really present, will *stop* the progress. Advise against branches or courses of study involving much close work, unless pupil is willing to wear correcting glasses.

Warn parents and children that in hypermetropia headaches, nervous symptoms of various kinds, and even ill health may result from this condition, even where no complaint is ever made of eyes or sight, and work and vision may be perfect.

Moderation in close work will usually relieve the condition; the use of proper glasses *for close work* will always relieve and enable the eyes to do full work without fatigue or other trouble.

In astigmatism, warn them that headaches, nervous difficulties, and ill health may be caused entirely by this condition, which must remain permanent unless relieved by the proper optical means.

IV.—THE GROWTH OF CHILDREN AS RELATED TO HEALTH AND ABILITY TO STUDY.

Closely related to the sanitary conditions of schoolhouses, are various other conditions affecting the child while in school; his health, the period of his rapid growth, the season of the year when this growth takes place, and the effect of this rapid growth upon his health and upon his consequent ability to do school work.

Since, under our system of education, children are kept in school, especially in the cities and the larger towns, about three-fourths of the time between the ages of 5 and 15 years, five or six hours a day, the important questions arise whether intellectual culture is not sought at the expense of bodily vigor, and whether the curriculum of studies is so arranged as to secure the best results with the least outlay of the pupils' strength; whether also the hardest study is assigned to that part of the year, and to that part of the course, when children are best able to accomplish it.

If children are taken into school and kept at work in study, so that their vital energies are exhausted at a time when their bodies ought to be developing, and if, consequently, the seeds of disease are being planted at a time when the foundation of future health should be laid, then it is of the greatest importance that the evil should be corrected.

In a new and sparsely settled country the springs are pure, and the question of drainage takes care of itself; the sewage is so small in quantity in comparison with the territory, that it is of little or no importance. In thickly settled communities the case is reversed; and the problem of the disposal of sewage, unimportant under the former conditions, becomes of serious import. There is a similar change of conditions in the problems relating to school life. When the number of months' schooling was small, and the child was occupied in other pursuits a large part of the year, health and growth were but little affected by the school. Since, at present, three-fourths of the child's time, in working hours, for the ten years of his life most important for health, growth, and bodily development, is spent in school, this question of health and growth becomes serious. And evidence is not wanting that our school life is liable to affect the health of children injuriously. Says Prof. A. Key, of Stockholm, in the Popular Science Monthly for Nov., 1890:

More and more sharply is the question of the influence of the present school system on the growing youth debated in every enlightened country of Europe. More and more distinctly is it declared, especially from the side of the doctors, that the school imposes too great demands upon the young organism in the critical period of its growth; that it, as well as all our education, seeks too onesidedly to stimulate mental growth, and that the physical development is thereby so neglected that great danger arises, perhaps fatal for the whole life, to the body as well as to the closely related mental health.

And in this country attention has been directed to the subject in many of the larger cities. In Boston, for example, a director of hygiene is employed by the school committee; and physical training is a part of the regular school course. Other towns and cities are following the example. There is no need, however, of any panic on this subject. The race is not likely suddenly to become extinct, as an immediate consequence of the present school system. And yet it behooves us to examine carefully whither the present system tends, and to apply the remedy in time if a remedy is needed. And the first step is to ascertain the facts. To this end Professor Key, just quoted, has made investigation of 15,000 boys and 3,000 girls of the schools of Denmark, Sweden, Belgium, Italy, and perhaps of other countries, as one of the Royal Swedish commission for this purpose; he has published the results; and the article quoted above gives certain conclusions. Among the most striking of these deductions as applicable to this country are these—

I. That boys pass through three distinct periods of growth; a moderate increase in the seventh and eighth years; a weaker growth from their ninth to their thirteenth years, and a much more rapid increase in height and weight from their fourteenth to their sixteenth years. * * * The development of girls also presents distinct periods, but the changes occur a few years earlier than in boys.

II. That children exhibit a relatively light growth from the end of November to the end of March. This period, which includes all the winter months, is followed by a second, from the end of March till July or August, during which the children grow rapidly in height, but their increase in weight is reduced to the minimum. After this follows a third period continuing to the end of November, in which the increase in height is very small and the gain in weight very large.

III. That of fifteen thousand boys in middle-schools, more than one-third are ill or are afflicted with chronic maladies. Shortsightedness, which is demonstrably for the most part induced by the overtaxing of the eyes in school work, and well merits the name of school-sickness, rises rapidly in height of prevalence from class to class. Thirteen and a half per cent. of the boys suffer from habitual headache, and nearly thirteen per cent. are pallid; and other diseases arise in the lower classes and then decline, to rise again in the upper classes.

IV. That the remarkable rise of the sickness-curve [a line drawn through a table of squares whose vertical lines represent the age and whose horizontal lines show the per cent. to represent the facts graphically] in the preparatory schools and the lower classes of the middle schools occurs exactly during the period from seven or eight years to thirteen years, the very one that has been shown to be one of weaker growth in boys. But as soon as the stronger growth sets in, and especially during the last years of that period, when the gain in weight is most rapid, the curve sinks from class to class, from year to year. . . . . When the yearly increase in weight and height begins to diminish rapidly, the sickness curve again rises very fast.

These investigations relate also to the time daily demanded by school for work and to the hours devoted to sleep; and

V. It was found that the amount of illness of those who worked longer than the average was 5.3 per cent. higher than that of those who worked less. * * * * The result was still more significant in the two lowest classes. The liability to illness there, in connection with the longer hours of work, was from 8.6 to 8.7 per cent. higher.

If the above deductions are correct, and if they are applicable to this country, then we may conclude (1) that boys can do most school work daily from March to November and least from November to March, and (2) that they should not be urged very rapidly from the years of 9 to 13, and that they can safely work hardest from 14 to 16 inclusive.

The age when girls can do their best work varies from that of the boys; but Professor Key's investigations relating to girls are less applicable to this country than those about boys; first, because they relate to comparatively few, and second, because the American school for girls is quite unlike the European school. It is more important, however, that school work should be properly adjusted to the ability of girls than that it should be adapted to the boys, because girls, as a rule, are more faithful to school duties than boys are, and they are not so strong.

In this country investigations similar to those of Professor Key, though less exhaustive, were made by Prof. H. P. Bowditch, M. D., of the Harvard Medical School, in 1875. They were authorized by the school committee of Boston, and they were made upon 13,691 boys and 10,904 girls—a total of 24,595 pupils. They relate to the height and weight only of children of American and of foreign parentage of ages 5 to 18 inclusive. These observations were made for only one year, and they belong to a single locality; and, consequently, any deductions made from them are liable to more or less error. Their value would be greatly increased if they could be continued and if they could be extended and compared with similar statistics from other places.

At Wellesley College the health officer or resident physician, it is understood, has secured valuable data relating to the effect of study in that institution upon the health of the young ladies. The late president of that institution, Mrs. Alice Freeman Palmer, is reported to have announced, as the result of her observations of the students through a series of years, that the health of students is not injured by study, and that their health improves under it. This is due no doubt to favorable conditions—a gymnasium, a resident physician, a well-considered curriculum, health of diet and regular hours. If satisfactory results have been attained in that institution they are possible elsewhere. It is probable, indeed, that equally good results have been secured in many other places with which I do not happen to be acquainted.

MEASUREMENTS OF WORCESTER SCHOOL CHILDREN.

In the line of Professor Key's investigations, examinations of some 2,000 or 2,500 children in the public schools of Worcester, Mass., were made during the spring of 1891 by Dr. Franz Boas, of Clark University. The measurements were authorized by the school committee of this city, as follows: Name; age; birthplace; nationality of father; of mother; occupation of father; residence; number of brothers; of sisters; [first, second, &c.] born child; sight; hearing; memory; stature or height [shoes off]; fingerreach; height sitting; length of head; width of head; height of face; width of face; weight; color of hair; of eyes.

The pupils were in the grammar and primary schools, of both sexes, and of ages from 5 to 15 or 16 years. Each child removed his shoes while one of the examiners noted the name, the age, residence, birthplace, nationality, and occupation of parents, number of brothers and sisters, &c.; a second pupil then took his place and he passed to the second examiner who took, and recorded, his height, sitting and standing, his fingerreach (the distance between the ends of his middle fingers with arms extended horizontally), the dimensions of the head, the weight, &c.; he then passed to a third examiner who tested his eyesight (by asking him to read letters of different sizes, at a certain distance), and noted the color of the eyes and the hair. The test of hearing was easily made by noting at what distance the pupil could readily hear the ticking of a watch. As soon as he returned to the schoolroom another pupil took his place. In this way the pupils left the room and returned one at a time without much interruption of school exercises; and each pupil was absent from the room from five to seven minutes only.

The principal labor of such an examination consists in tabulating the results from the printed blanks on which they are written, and averaging them. If these examinations can be continued for a series of years, so that the measurements of the same pupil year after year can be compared, then the period of greatest growth can be more accurately determined; and the larger the number of pupils the more accurately will the averages determine this period. For the greatest usefulness, also, data are required concerning the health of children when in school, in order to determine whether there is more sickness among them during the period of slow growth than there is among European children; and for obtaining such data no means has yet been provided.

The memory test is very simple and quite interesting. It was conducted by the teacher, with the whole class. All the pupils sat at their desks with paper and pencil before them; and the teacher, having first secured their attention, read a line of six figures; at a signal, a moment after, each child took his pencil and wrote the line; a second line of figures, and then a third was read by the teacher and written by the pupil in the same manner. After this, three lines of seven figures each were written by the pupils in the same way; and then, three lines of eight figures each—of course the figures being varied each time. The teacher next read the figures in order, and the pupils (perhaps after exchanging papers) marked all that were wrong. If this test is adapted to the capacity of the pupils, with not too many figures at a time for the younger children, it is very curious to note how much smaller will be the per cent. of errors in the morning, when the children are fresh, than near the close of the session, when they are weary. It is a test of fatigue as well of memory and attention. This may throw light upon the order in which studies should follow each other during the day.

It is too early for the results of the measurements of children in this city to be announced, but one or two results are already known.

Of the children examined about 10 per cent. have defective eyesight. In some cases, probably a large number, neither the pupil nor his parents were aware of the defect; and when undiscovered not only is the difficulty liable to increase, but the pupil may appear stupid, lose courage, and fail to improve, when the real difficulty is that he can not see, while supposing that he sees as well as anybody. There are many well-authenticated instances of this kind. The same is true of defective hearing. To relieve such unfortunate pupils is worthy of great effort by a teacher, and any investigation which brings such relief in any considerable number of instances, is well repaid.

A second result thus far announced relates to the growth of the face, and it is said to be of considerable interest. [See Science, Vol. XVIII, No. 439.]

There seem to be three distinct periods [of this growth in the female face], the first ending about the seventh year, and the third beginning about the fifteenth year. A striking peculiarity is the seemingly abrupt transition from the types of one period to those of the succeeding. The sudden disappearance of the lower widths of the face, and the equally sudden appearance of the types of the succeeding period, *e. g.*, the sudden shooting up of the widths to almost adult dimensions at about the age of eight or nine, offset by the equally sudden disappearance of the distinctively childish characteristics at the age of eleven.

The significance of this observation may appear when it is remembered that the development of the face is known to correspond intimately with that of the brain.

How much value educationally there may turn out to be in these particular investigations I do not pretend to know. They are detailed here, imperfectly to be sure, in order to show that something has been done and is being done in the important direction of determining the effect of physical growth upon ability to do school work, and the effect of school life upon the health of children, and in order if possible, also to stimulate similar investigations among those who may read this circular.

CONCLUSION.

In the following appendices from different sources, statements may appear more or less at variance with another and with those in the body of this circular. It is proper, therefore, in conclusion for me to indicate what on the whole appears to me best. This I will do in the form of a general summary:

I.

(1) The basement of a schoolhouse should be at least from one-half to three-fifths of its height above ground, in order that it may be well lighted and airy.

(2) The stairs leading into the building should be under cover in all cases, to be free from ice and snow in winter.

(3) The pavement in all basements and water-closets should be of Portland cement. (See Mr. Philbrick's report, page 45.)

(4) In all houses of more than one story there should be at least two flights of stairs, at a distance from each other—the one for boys and the other for girls; and both flights should be accessible from every room in the house to avoid all possible danger from fire. In cities the stair cases should be fireproof.

II.

(5) The window-sills should be 4 feet high, and the windows should extend to the ceiling—no matter what the architect says.

(6) The windows should be massed at the left of the pupils, and near the back corner; one or two at the back near the left corner, and the rest along the side.

(7) The schoolroom should be narrow from left to right, the inner seat being distant from the windows not more than one-and-a-half times the height of the top of the window; the broad aisle at the back of the room.

(8) Light curtains to roll from the top should be placed in all windows exposed to the direct rays of the sun, and opaque shades to roll from the bottom, or best of all the sliding blinds. (See pp. 53–55.)

(9) The teacher's platform need not face the light, or if it does the teacher need not always sit facing the glare of a window. The light should accommodate the pupils; the teacher can vary his position by facing his desk towards the right of the pupils and sitting in the front

corner at their left. There is no law to compel a teacher to sit square in front of pupils and in the middle of the front side of the room, but there should be a regulation compelling the accommodation of the light to the pupils' eyes, since they are not at liberty to change their position at will as the teacher is.

(10) The south light is better for a schoolroom than the east light and the west light, which admit the slanting rays of the sun, or than the north light which does not admit the sun's rays at all. But for a drawing class the north light is best because the shadows are uniform at all hours of the day.

III.

(11) Air should be admitted to the schoolroom 8 feet above the floor, and exhausted at a height not more than 1 foot above the floor.

(12) Fresh air should never be admitted to a school-room through underground ducts.

(13) Air for admission to a schoolroom should never be heated above 100° F.; and the quantity should never be less than 20 cubic feet per pupil per minute.

(14) If a fan is used for ventilation, the "plenum system" should be used, by which the fan forces the air inward, and not the exhaust, by which the air is sucked out of the room; though in large buildings the two may be combined without injurious effects.

(15) For comfort and economy, double windows should be placed in all schoolhouses in winter in cold climates.

PLATES.

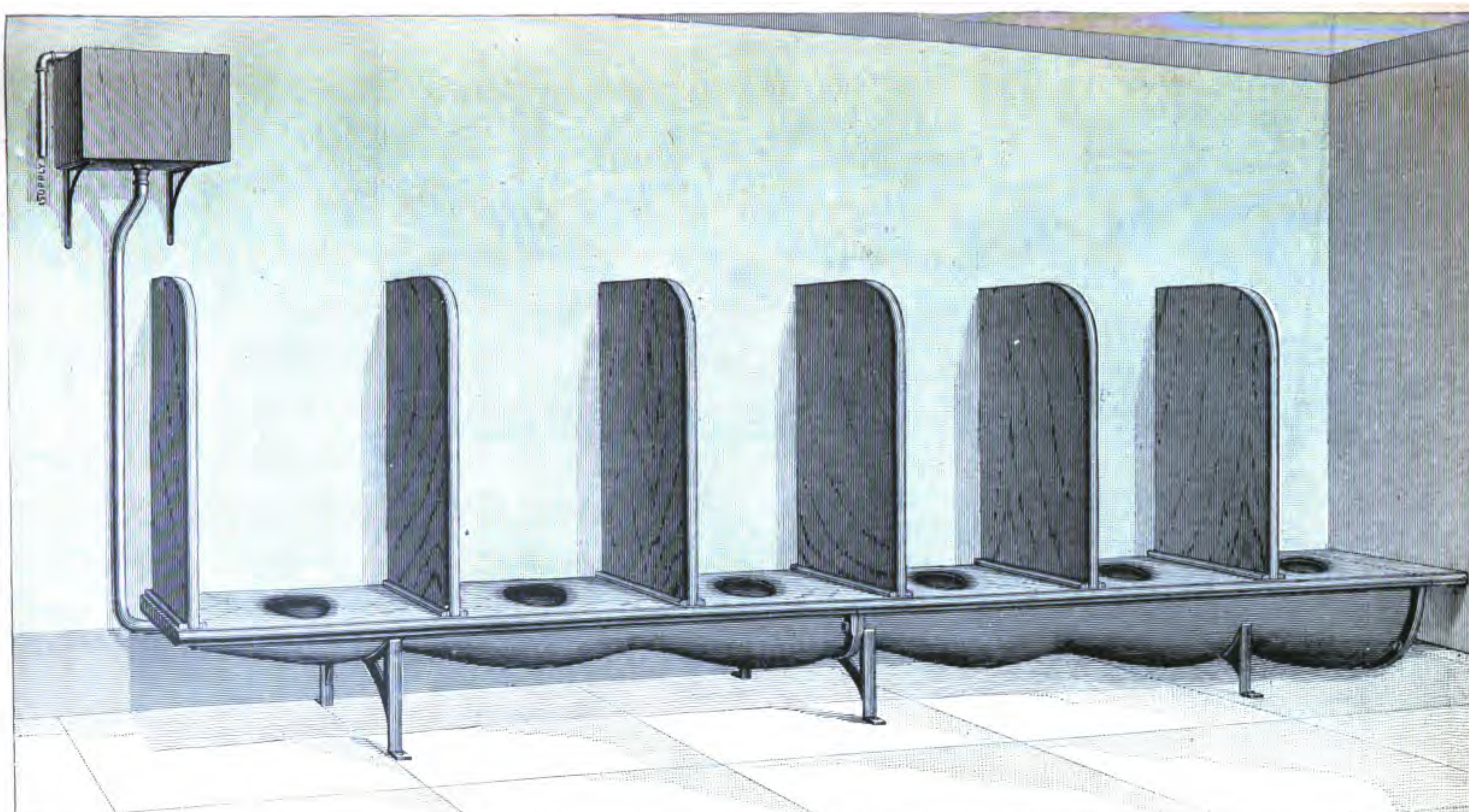
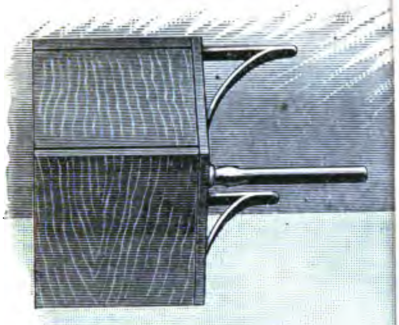


FIG. 32.—A six-section apparatus of the "Parsons" trough water-closets, fitted up with automatic tank. If not desired, the partitions may be dispensed with, as shown in next figure, but each section should be roomed off separately in the same manner as a row of single closets (see Fig. 35).



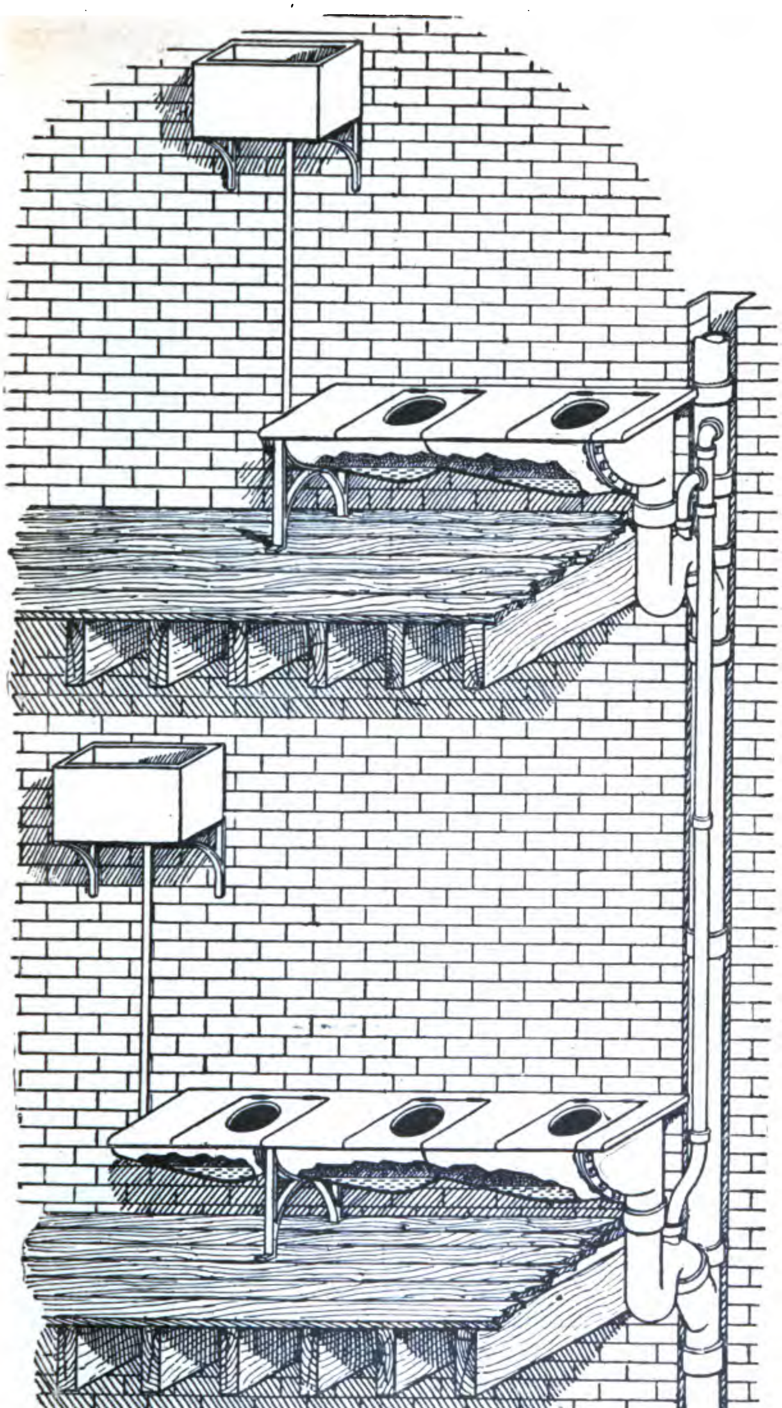
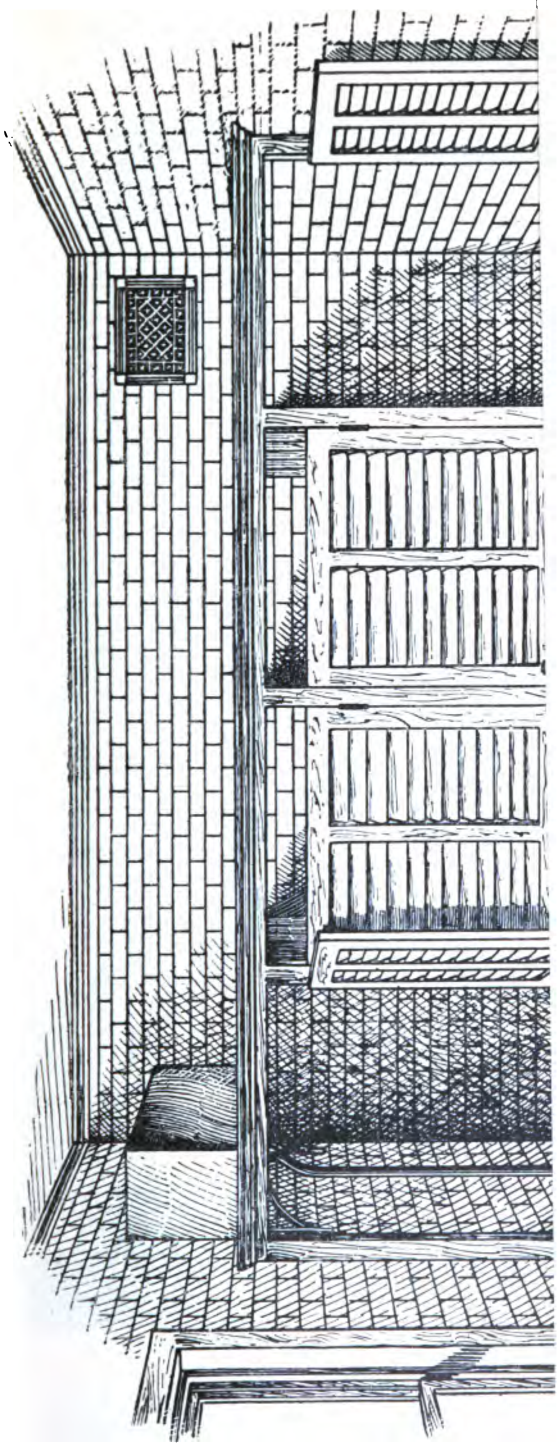


Fig. 34.—View showing the adaptation of the "Parsons" trough system in two or three person closets, for mills, factories, stores, tenements, etc., where it is desired to have them located on different floors. If preferred, the trough can be turned around, placing the outlet in the opposite direction. The supply to the tanks can be so arranged that the water can be turned on or off the whole system by a valve located on the lower floor. In this plate the front of the trough is cut away, showing the water lèvel in each basin. Care should be taken that the seats are placed directly over the centers of the basins.



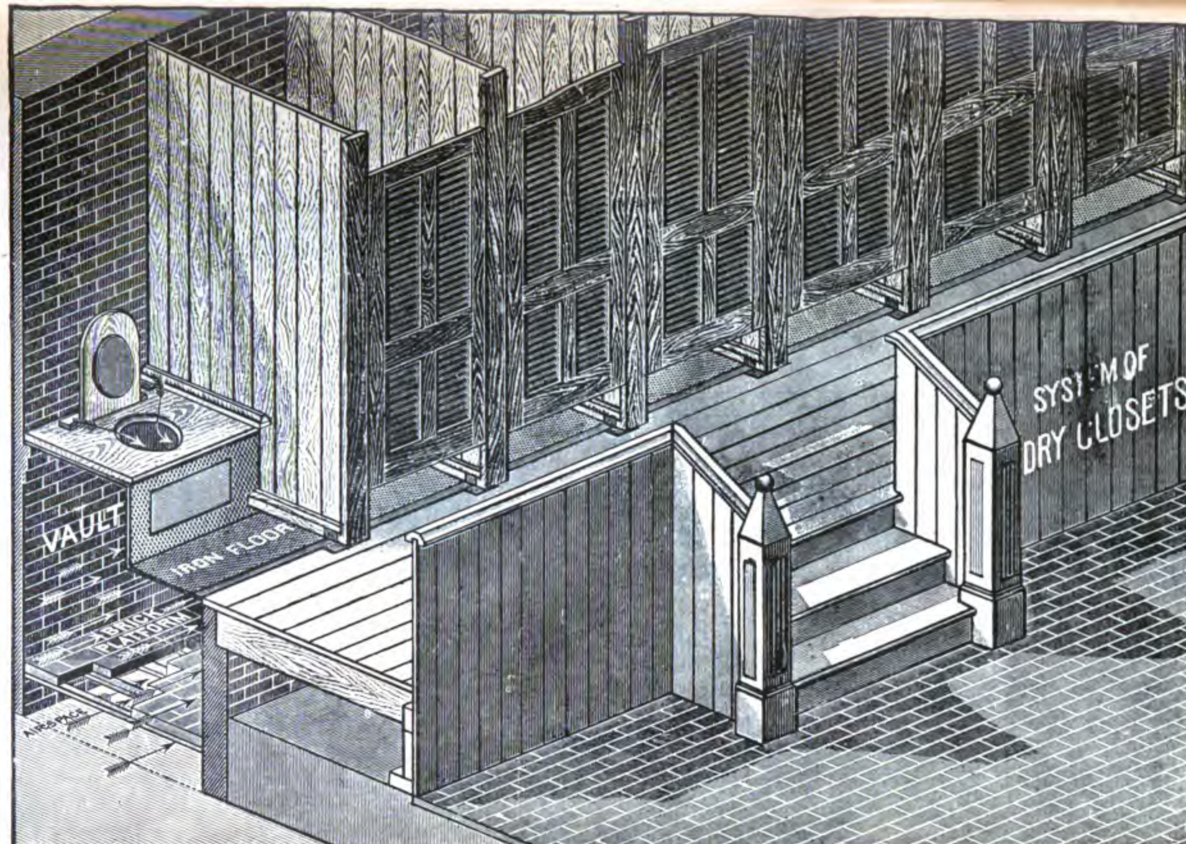
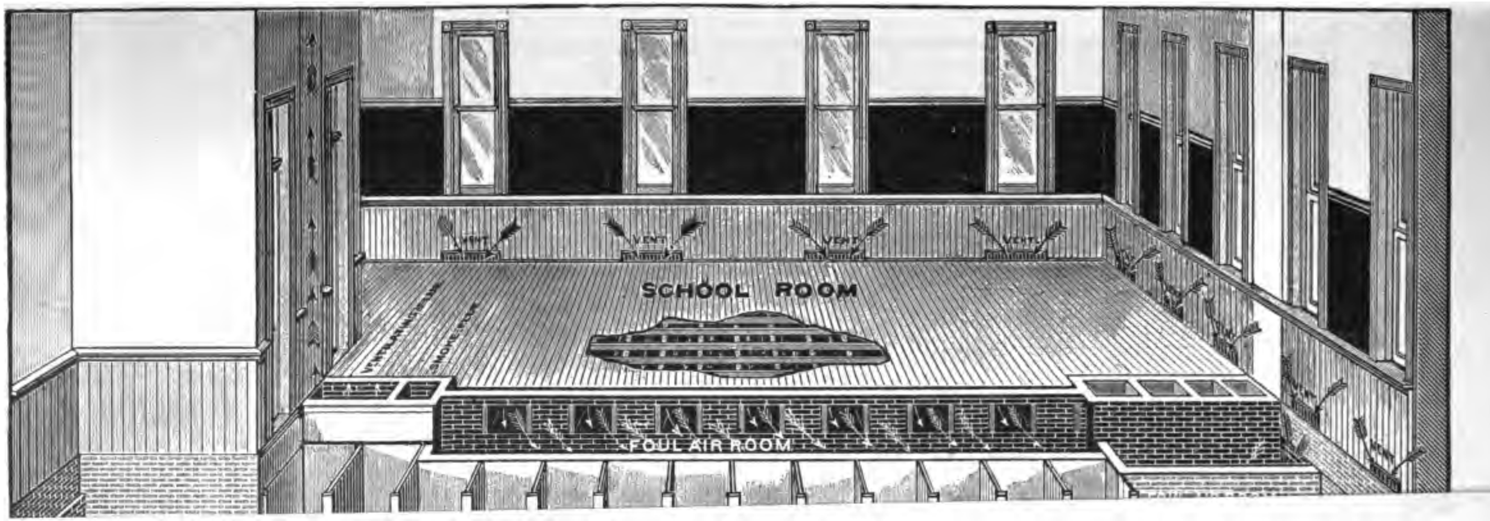


Fig. 36.—Perspective view of the system of dry closets.



SCHOOL ROOM
VENT.
VENT.
VENT.
VENT.
SMOKE FLUE
FOUL AIR ROOM

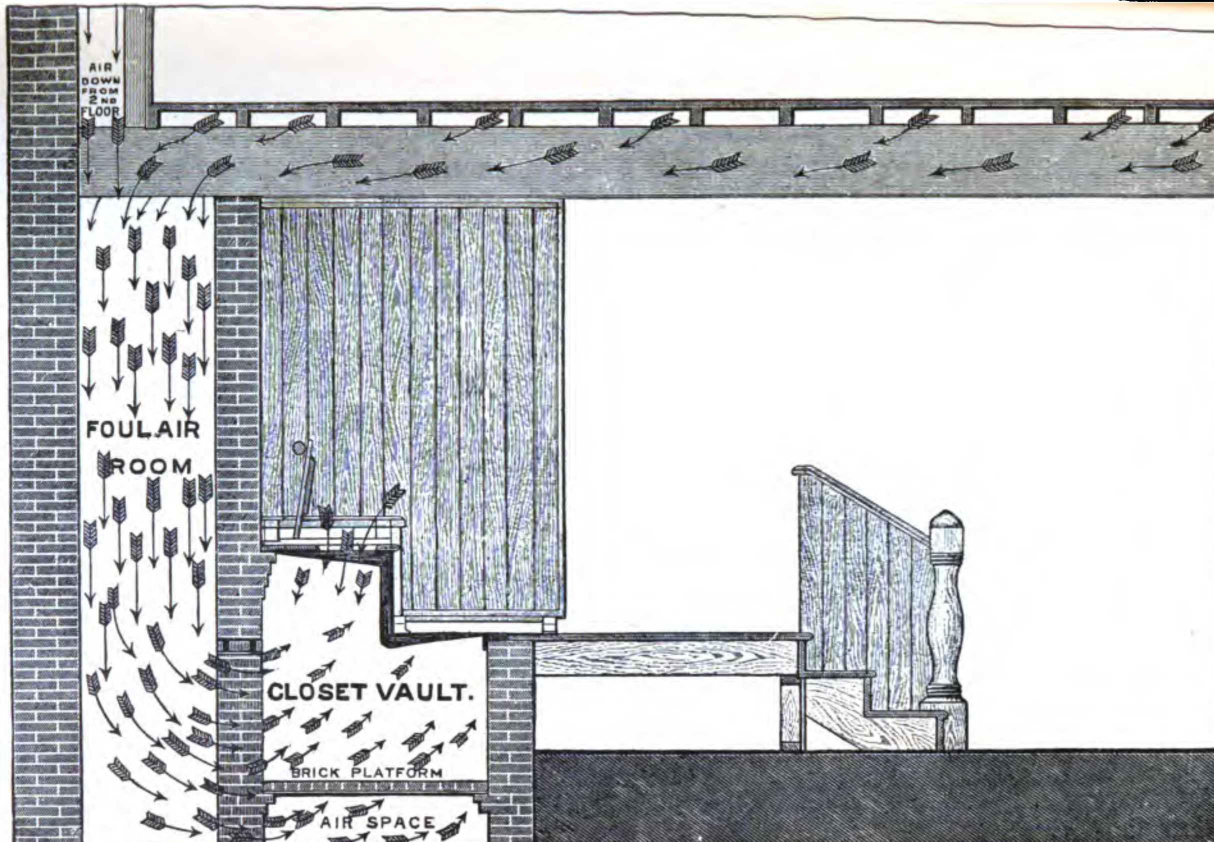
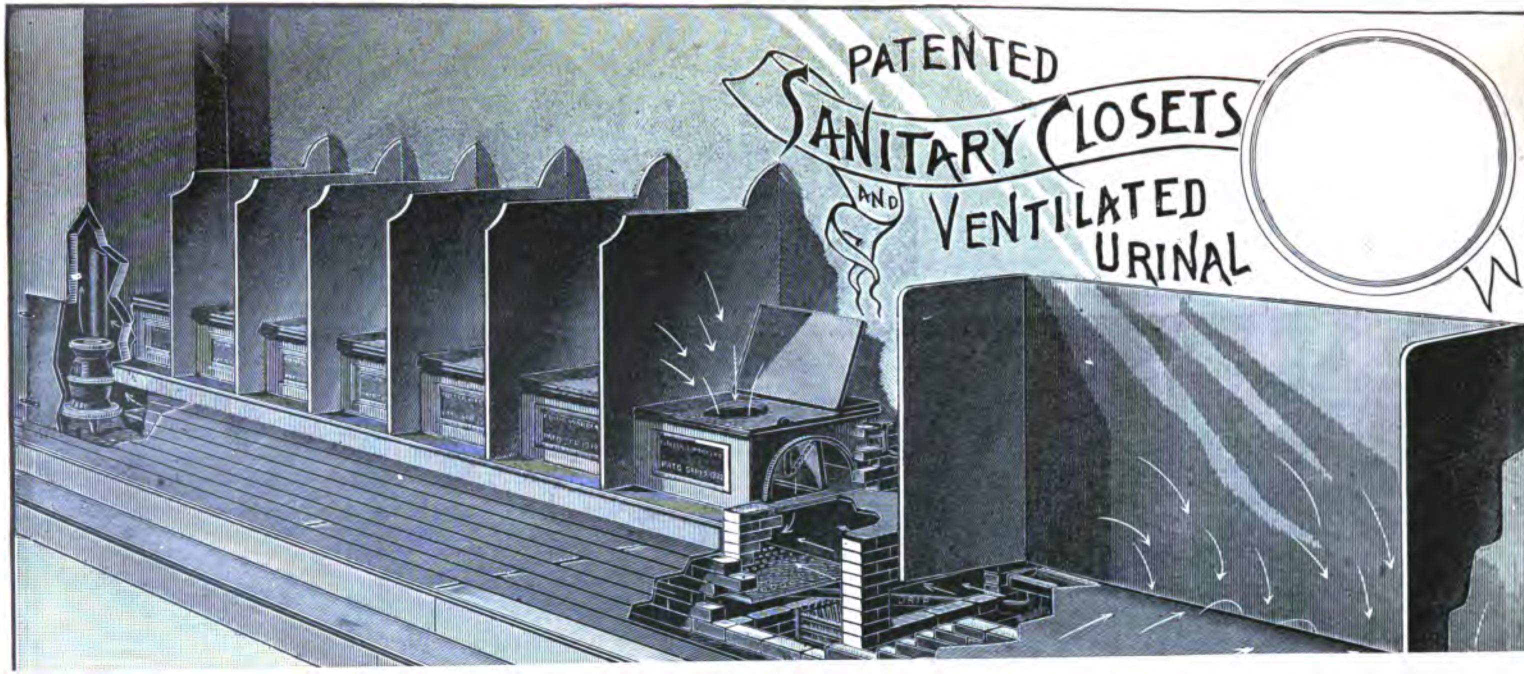


FIG. 38.—Section through dry closet vault and foul-air room, Segur Avenue school building, Toledo, Ohio. (Designed and patented by Isaac D. Smead.)


PATENTED
SANITARY CLOSETS
AND
VENTILATED
URINAL

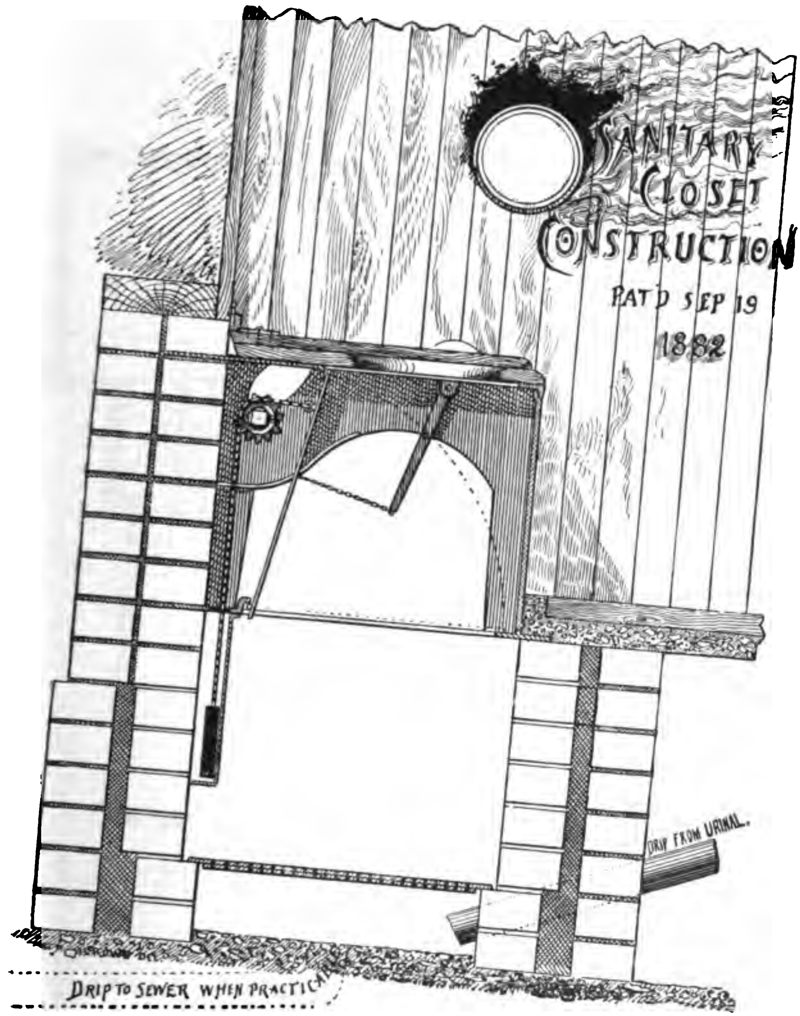

SANITARY CLOSET CONSTRUCTION
PAT'D SEP 19 1882
DRIP FROM URINAL.
DRIP TO SEWER WHEN PRACTICA

Fig. 41.

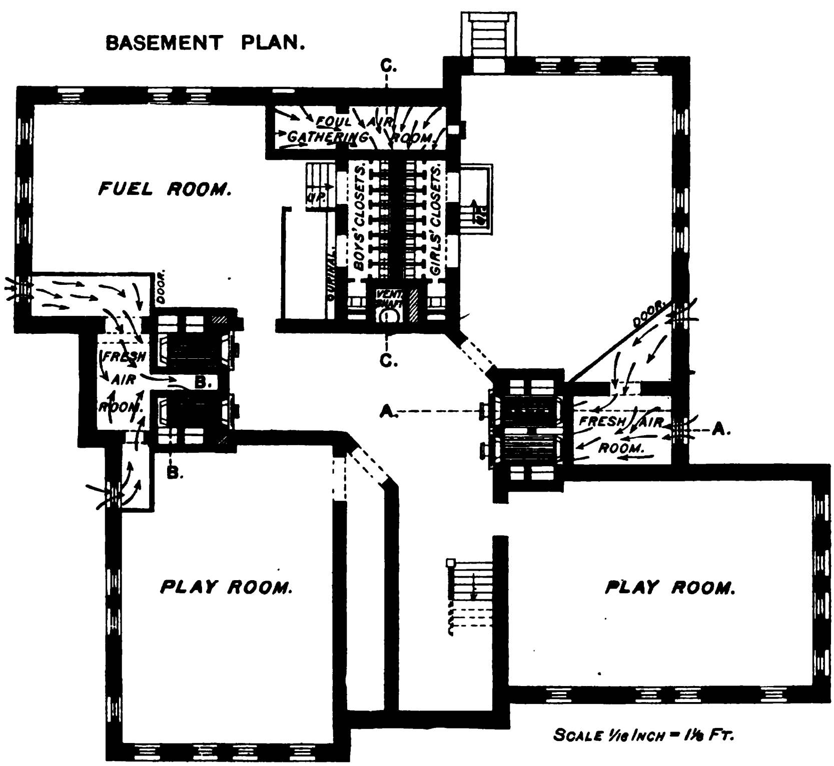


FIG. 42.—Basement plan of South Street school building, Toledo, Ohio, showing furnaces, cold-air rooms, foul-air rooms, system of dry closets, warm-air flues, ventilating and smoke flue.

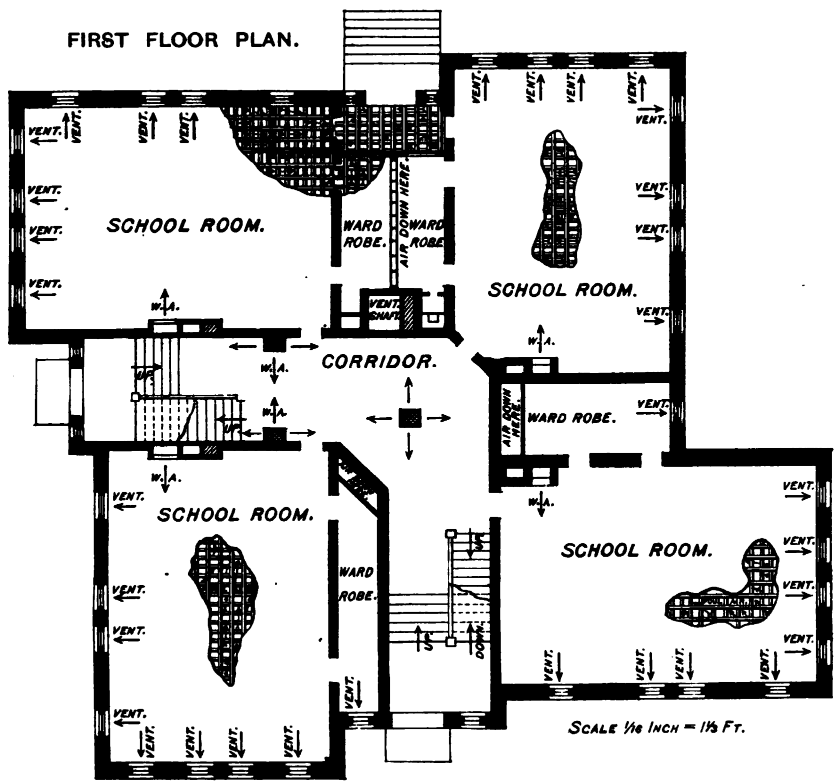


FIG. 43.—South Street school building, Toledo, Ohio; representing, by breaks in the floors, the passage of air under them; location of main air register in school rooms and corridors, and also location of foul air exits before it passes under floor.

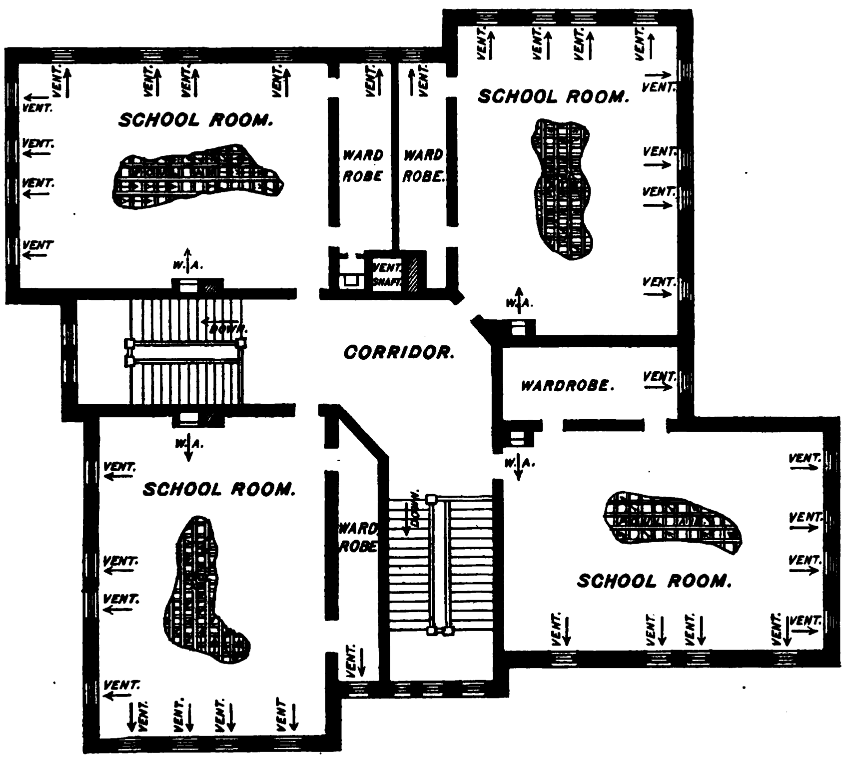


FIG. 44.—Plan of second floor, South Street school building, Toledo, Ohio.

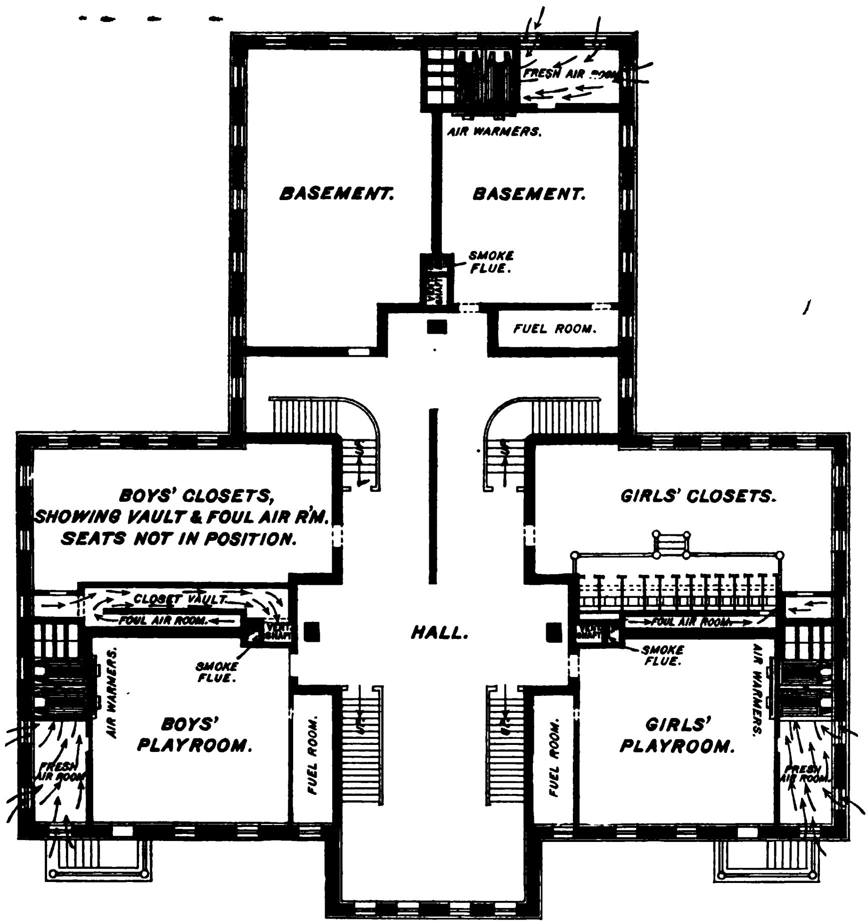


FIG. 45.—Basement plan of Segur Avenue school building, Toledo, Ohio.

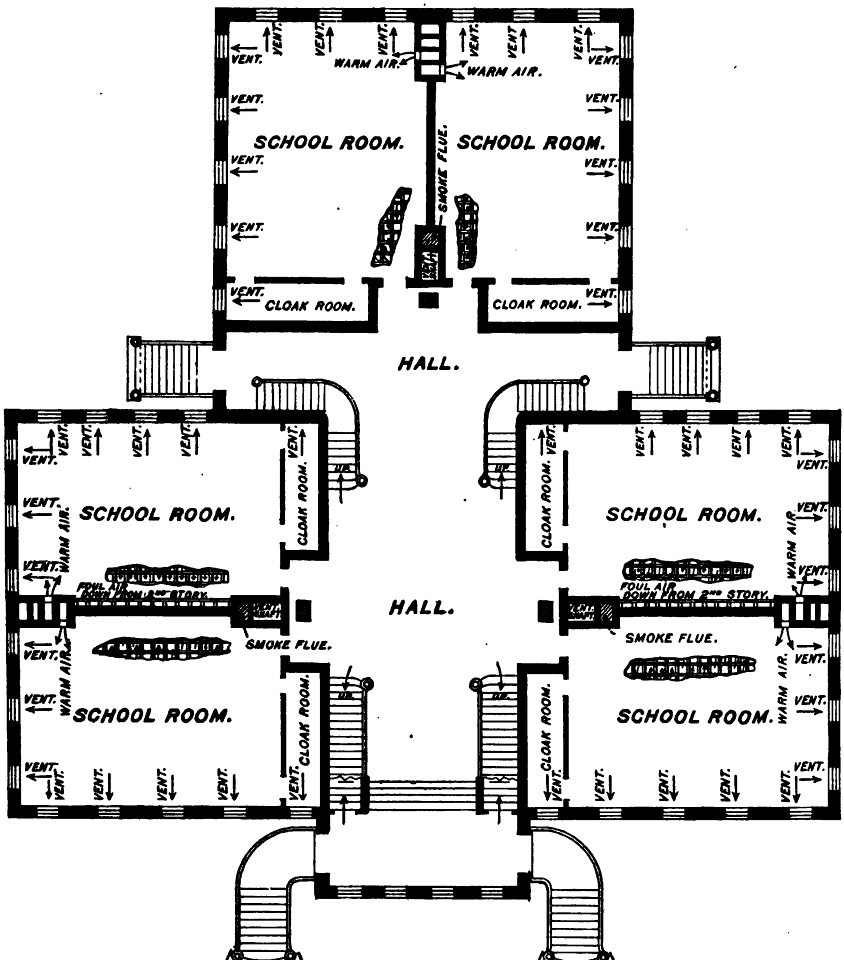


FIG. 46.—First floor plan of Segur Avenue school building, Toledo, Ohio.

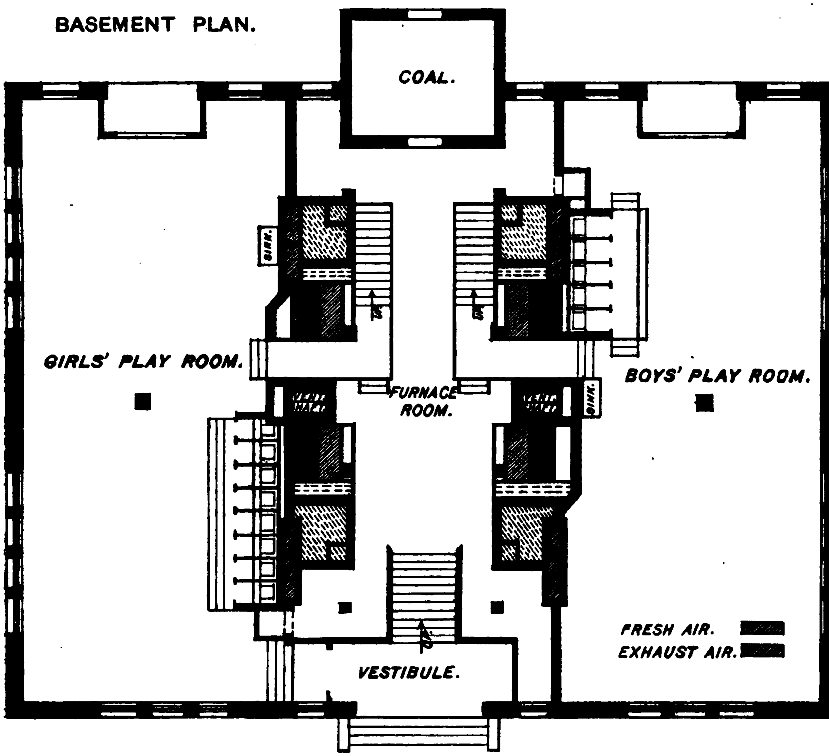


Fig. 50.—Basement plan of Concord Square School, Somerville, Mass.

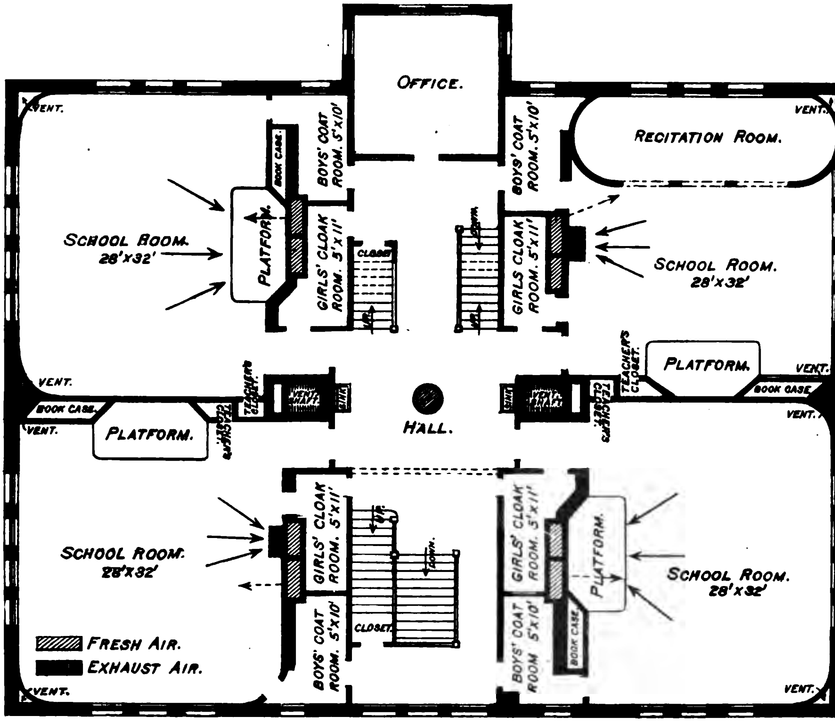


Fig. 51.—Concord Square school, Somerville, Mass. (First floor plan.)

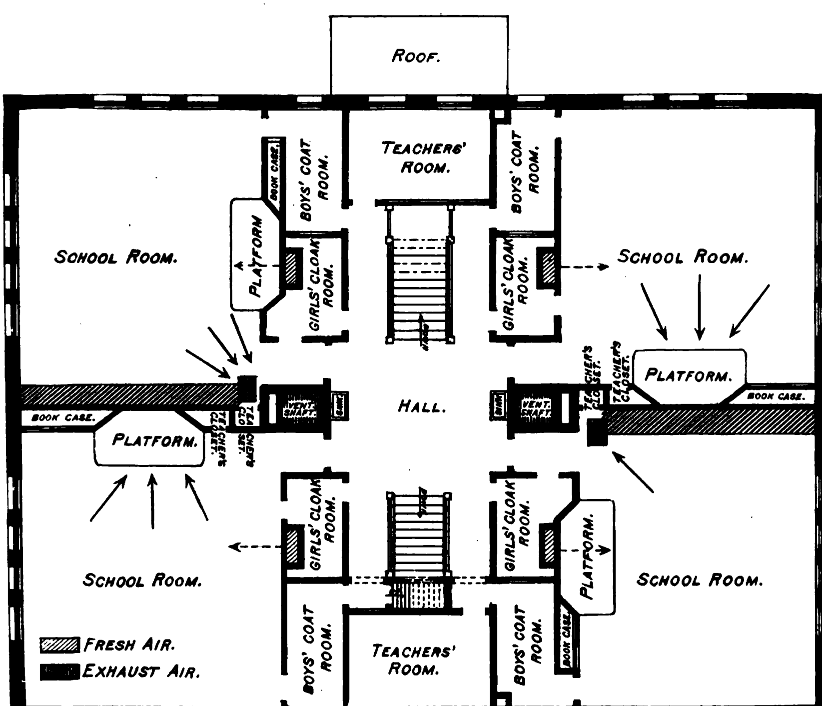


Fig. 52.—Concord Square school, Somerville, Mass. (Second floor plan.)

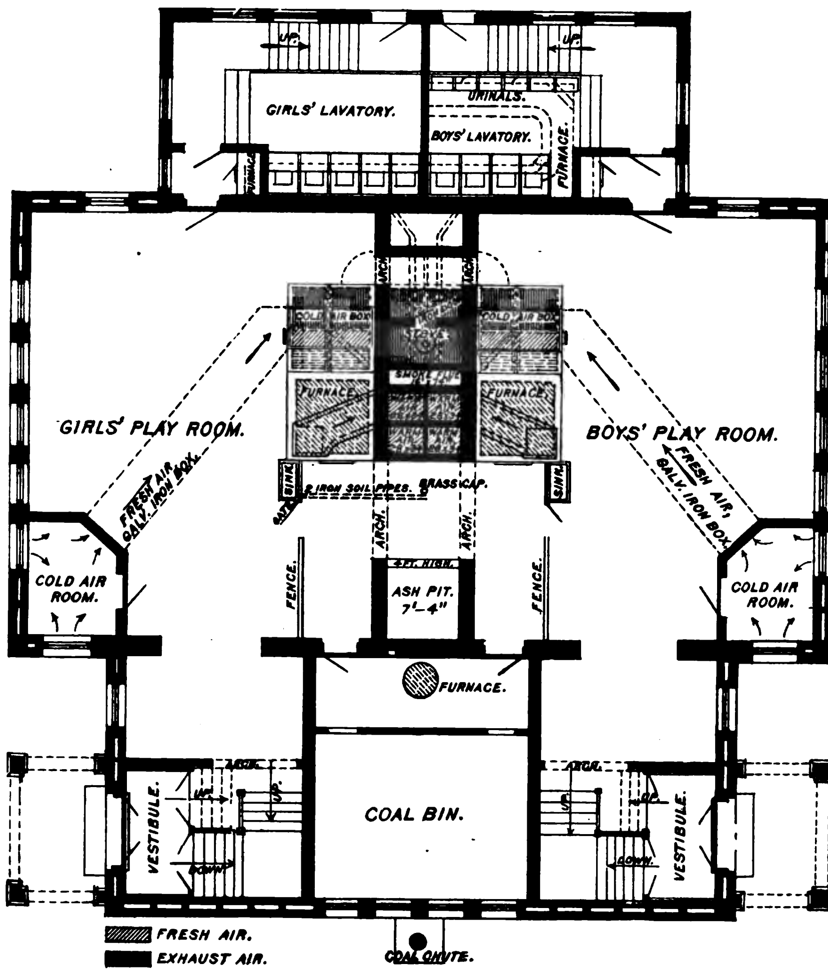


FIG. 53.—Quinsigamond schoolhouse, Worcester, Mass. (Basement plan.)

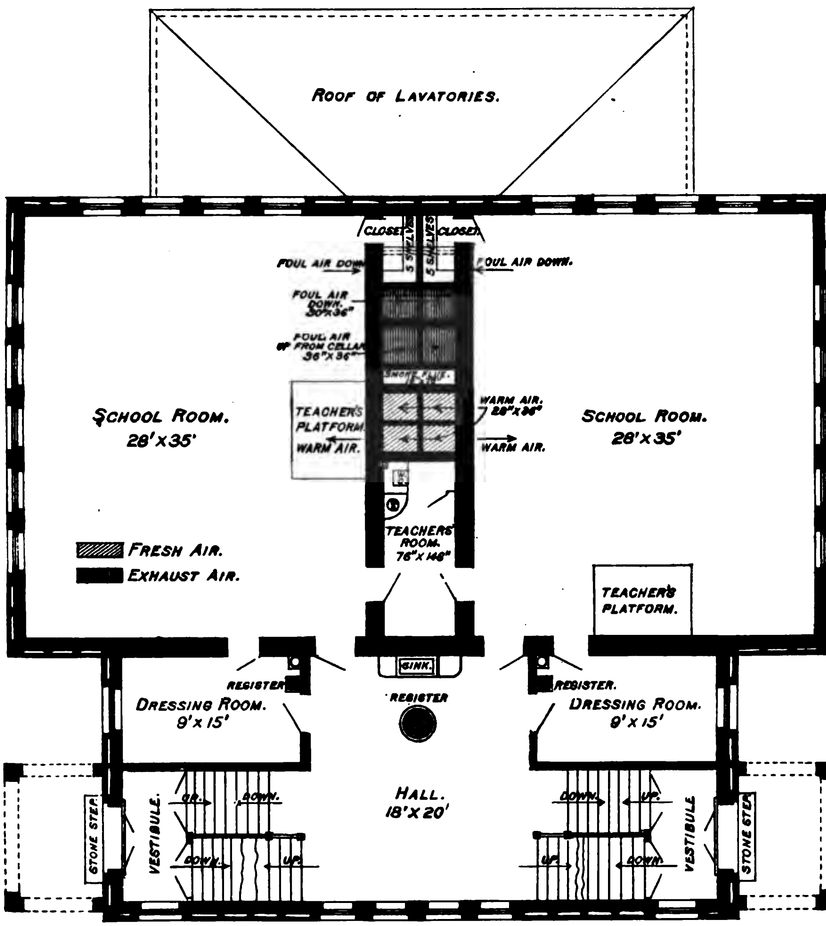


FIG. 54. Quinsigamond schoolhouse, Worcester, Mass. (First floor plan.)

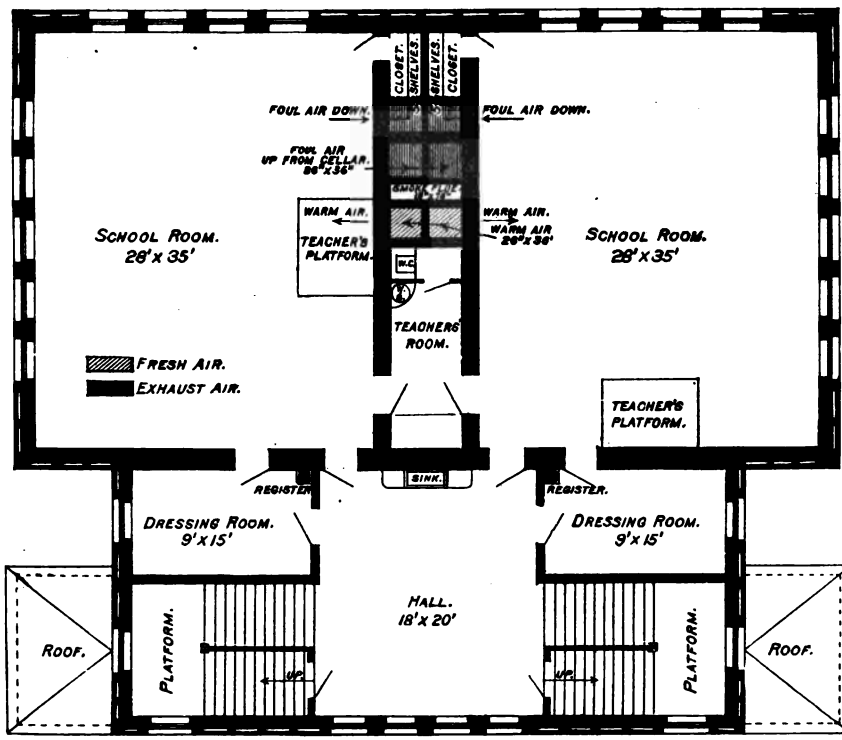


FIG. 55.—Quinsigamond schoolhouse, Worcester, Mass. (Second floor plan.)

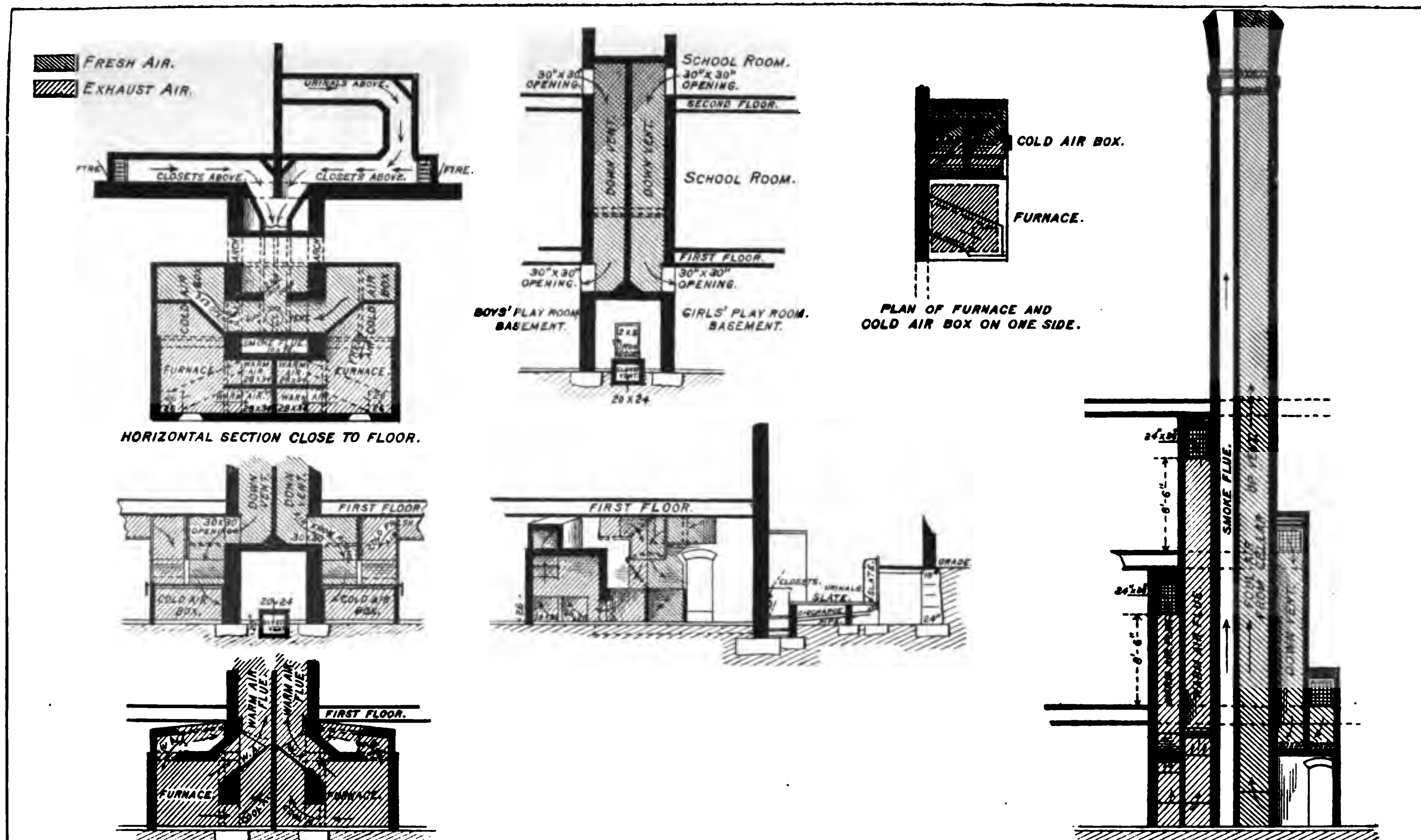


FIG. 56.—Quinsigamond schoolhouse, Worcester. Mass. Details showing brickwork required for warming, ventilation, and sanitaries.

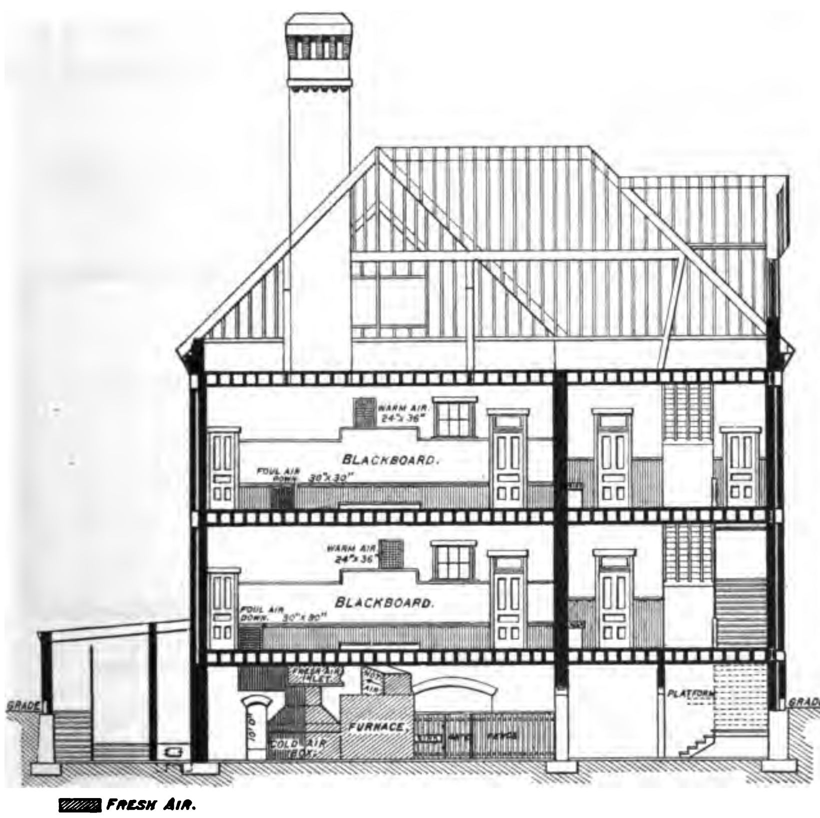


FIG. 57.—Quinsigamond schoolhouse, Worcester, Mass. (Sectional plan.)

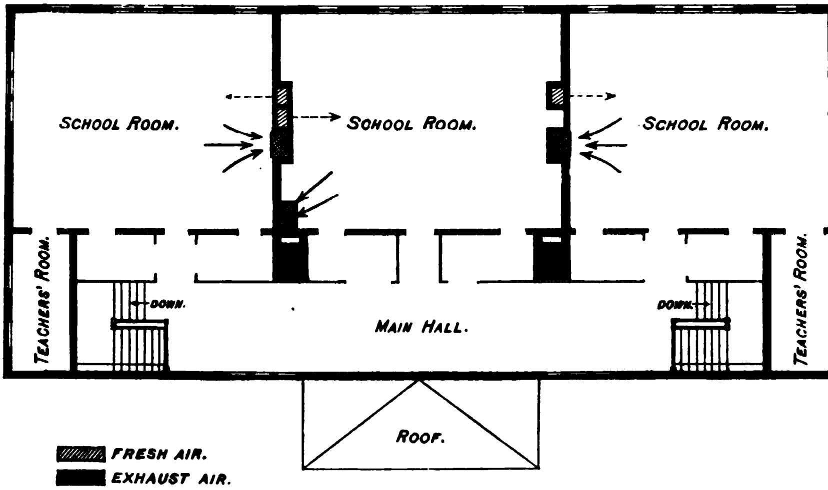


FIG. 58.—The Bryant school, Great Barrington, Mass. (Second floor plan.)

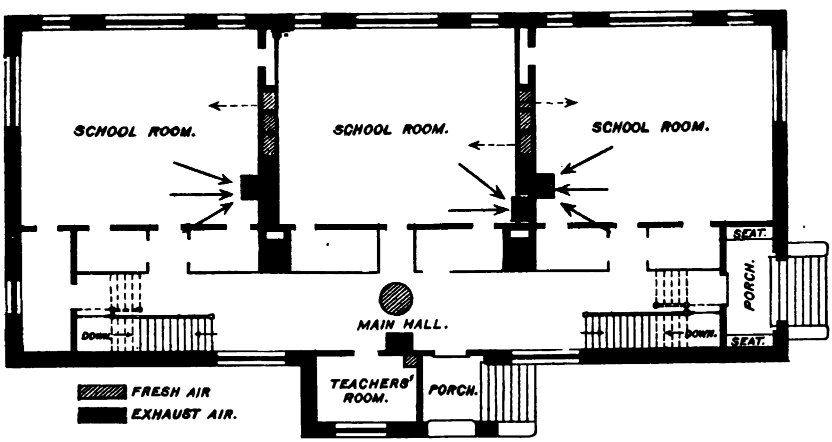


FIG. 59.—The Bryant school, Great Barrington, Mass. (First floor plan.)

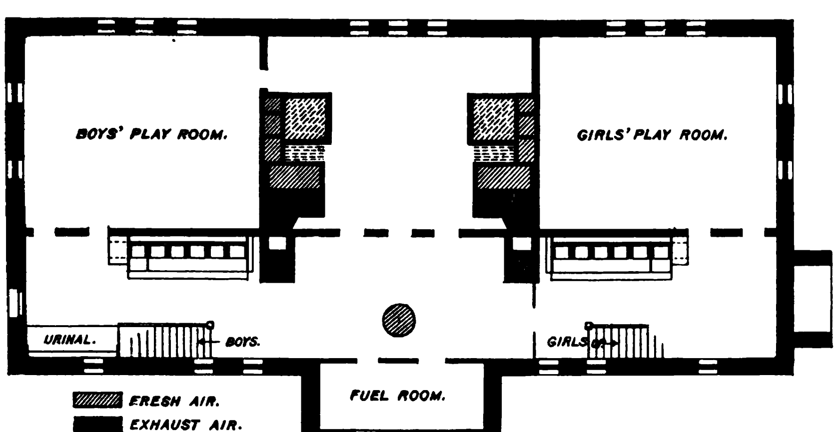


FIG. 60.—The Bryant school, Great Barrington, Mass. (Basement floor plan.)

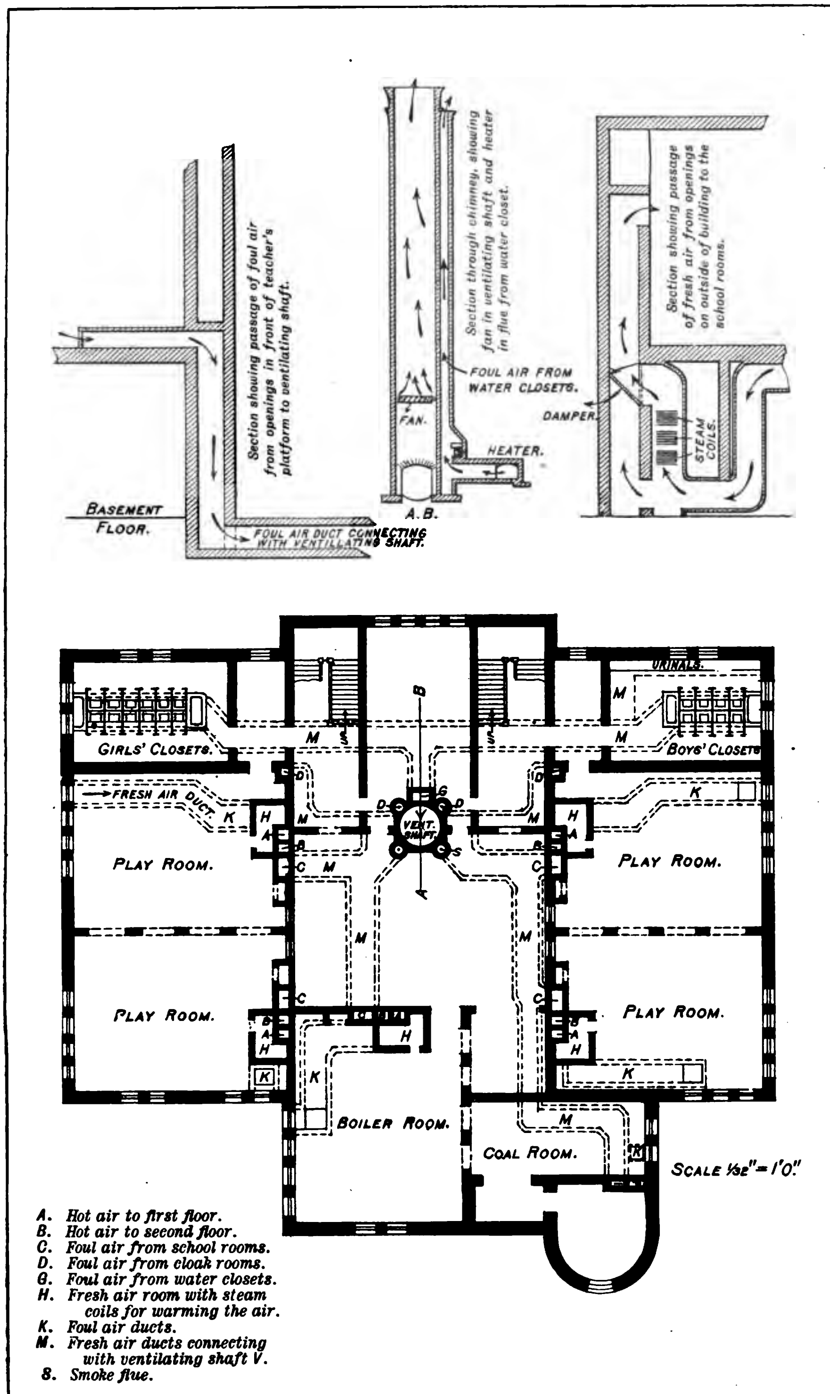


FIG. 61.—Salisbury Street schoolhouse, Worcester, Mass. (Basement plan.)

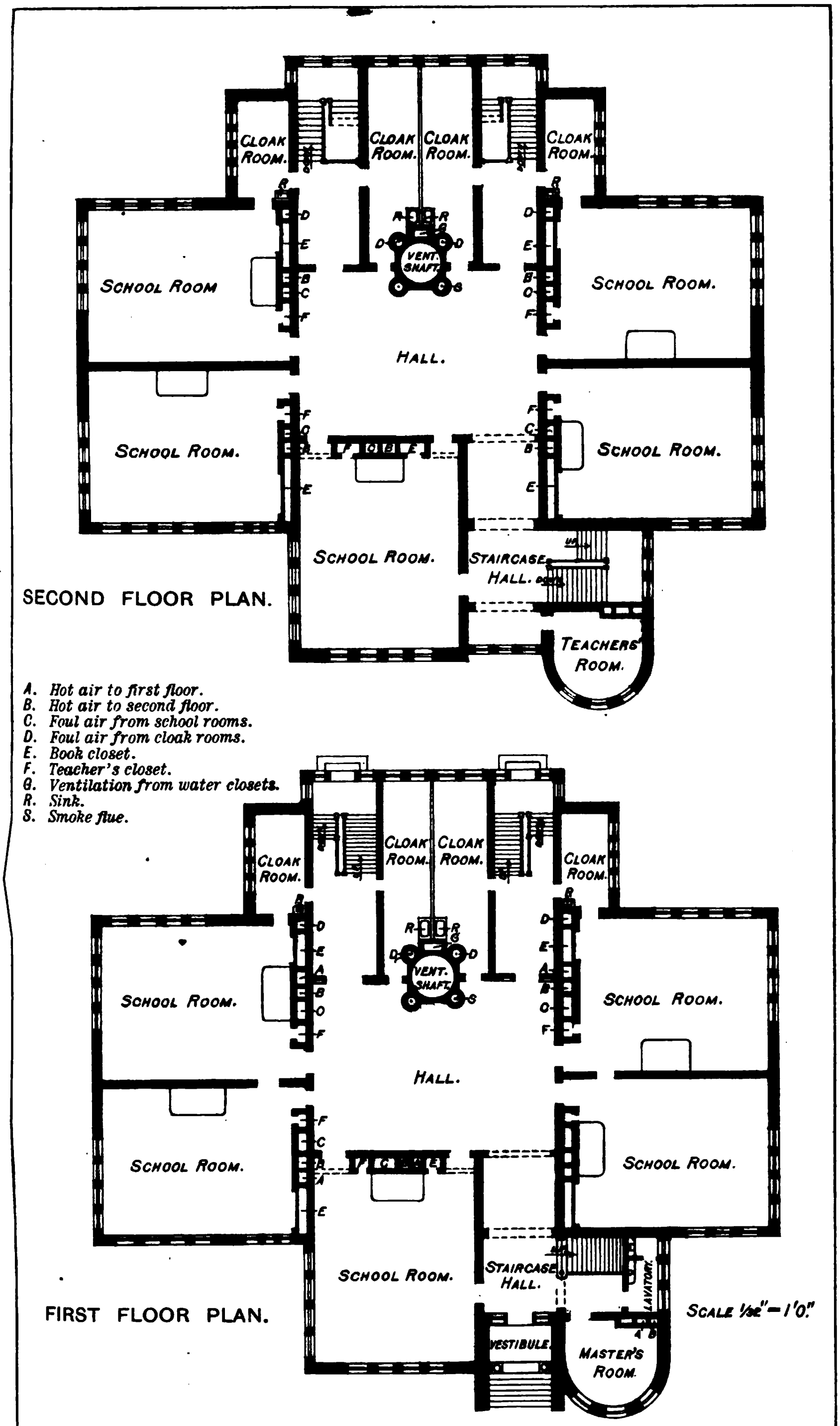


FIG. 62.—Salisbury Street schoolhouse, Worcester, Mass.

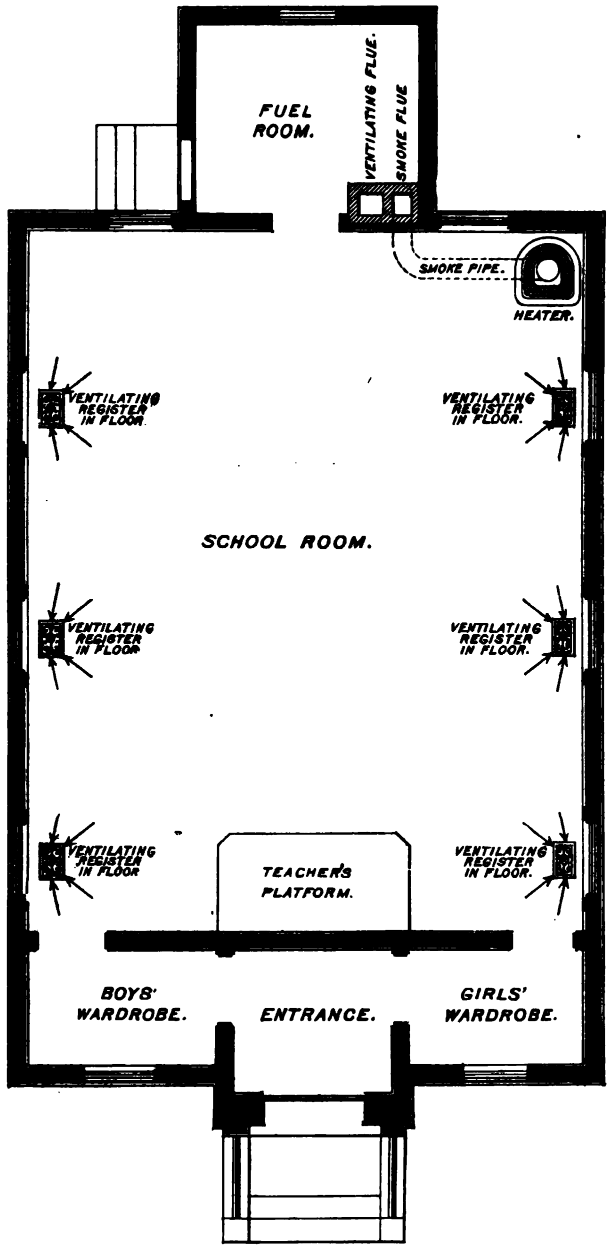


FIG. 68.—Floor plan of the model district school.

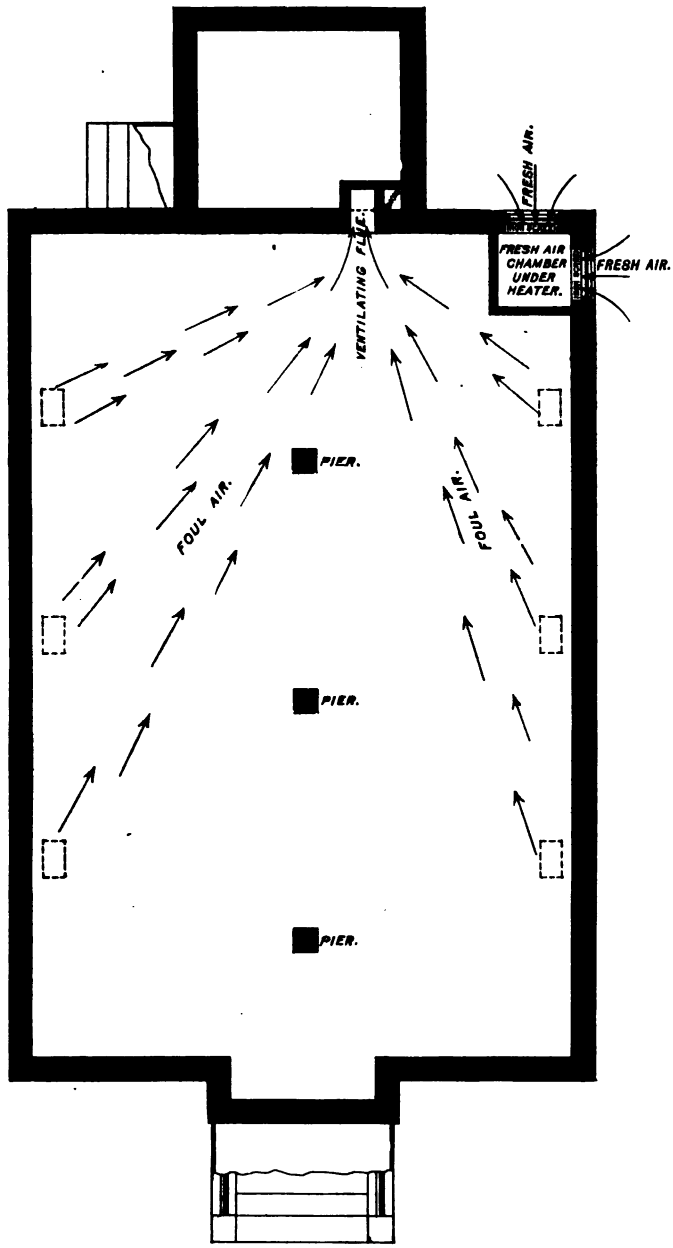


Fig. 64.—Ground plan of the model district school.

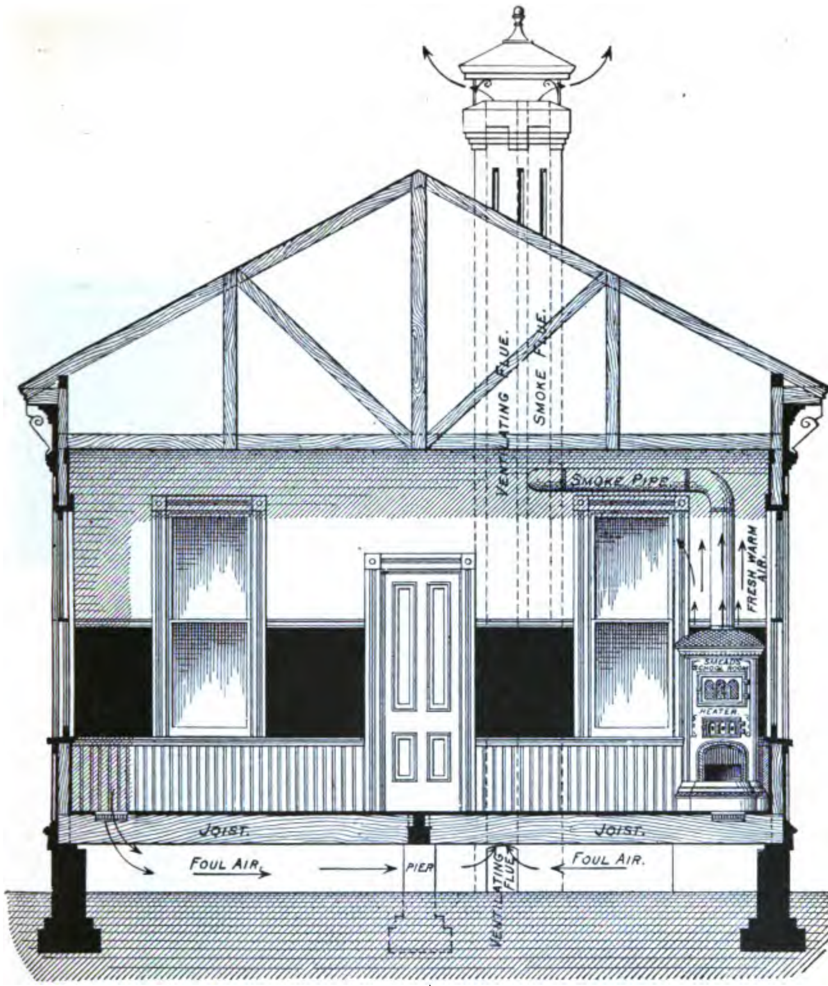


Fig. 65.—Section of the model district school.

The model district and ward school building. —Considerable sums are expended in arranging to warm and ventilate large school buildings, while the district school and ward buildings are always warmed with a common stove, and generally a *second-hand* one from some larger building, and no attention whatever is paid to the important question of ventilation. Holes are left in the foundation walls through which the air can pass to prevent decay of joists and sills. This, of course, renders the temperature of space under the floor same as temperature outside (anywhere from 0 to 30° below), and the pupils sit all day with a board 1 inch in thickness between their feet and this sea of cold air, while their heads and bodies are in a temperature of from 40° to 90°, according to distance of seat from the stove, and this, too, in air which may have been breathed a dozen times. Who can wonder that they have cold feet, and are sometimes restless and unwilling to study, and that many are sick and unable to attend school more than one-half or two-thirds of the time? The plan of warming and ventilating buildings of this class represented above can not but commend itself to all who will for a moment consider the two conditions. An entire change of air in the building every 30 minutes, temperature the same in all parts of the room, warm instead of cold air under the floor, should certainly be worth all it costs.

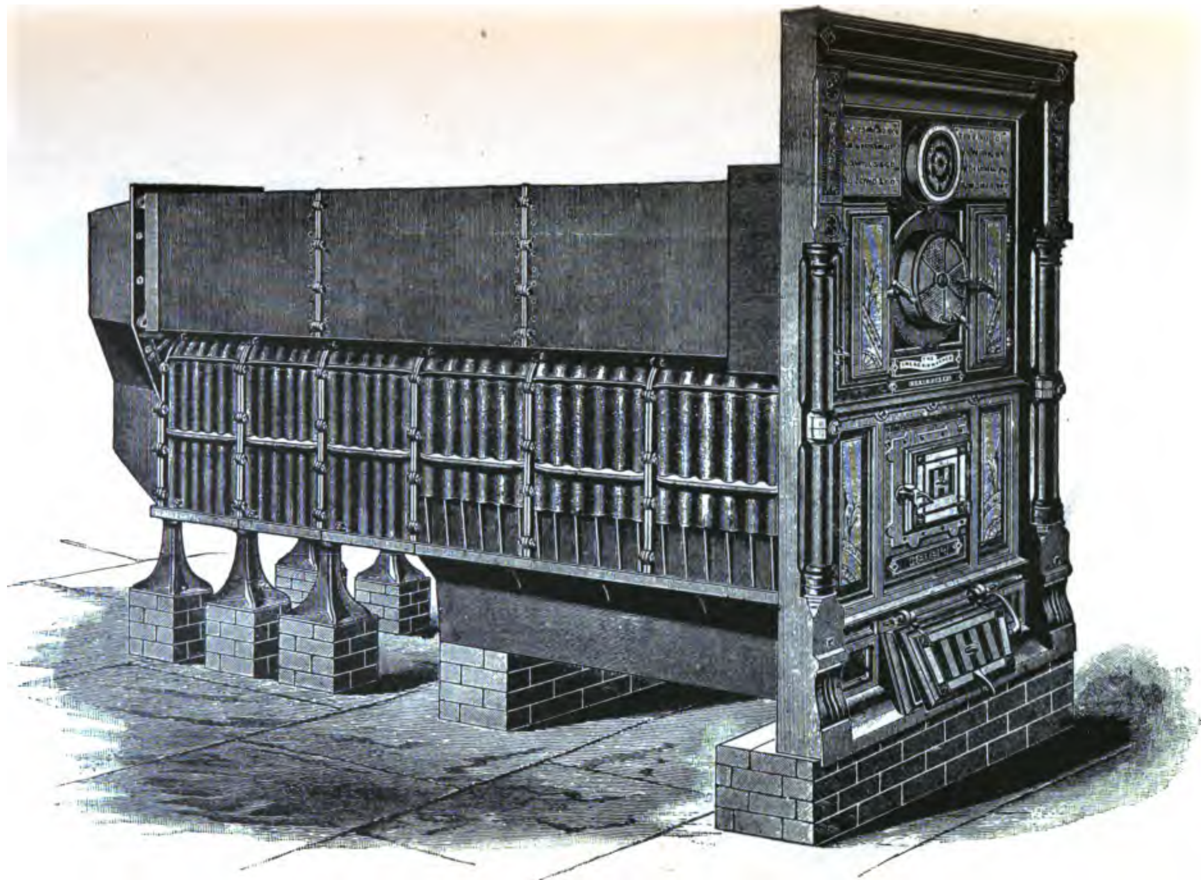


FIG. 66.—The air-warmer. [Large radiating surface, moderately heated.—A. P. M—.]

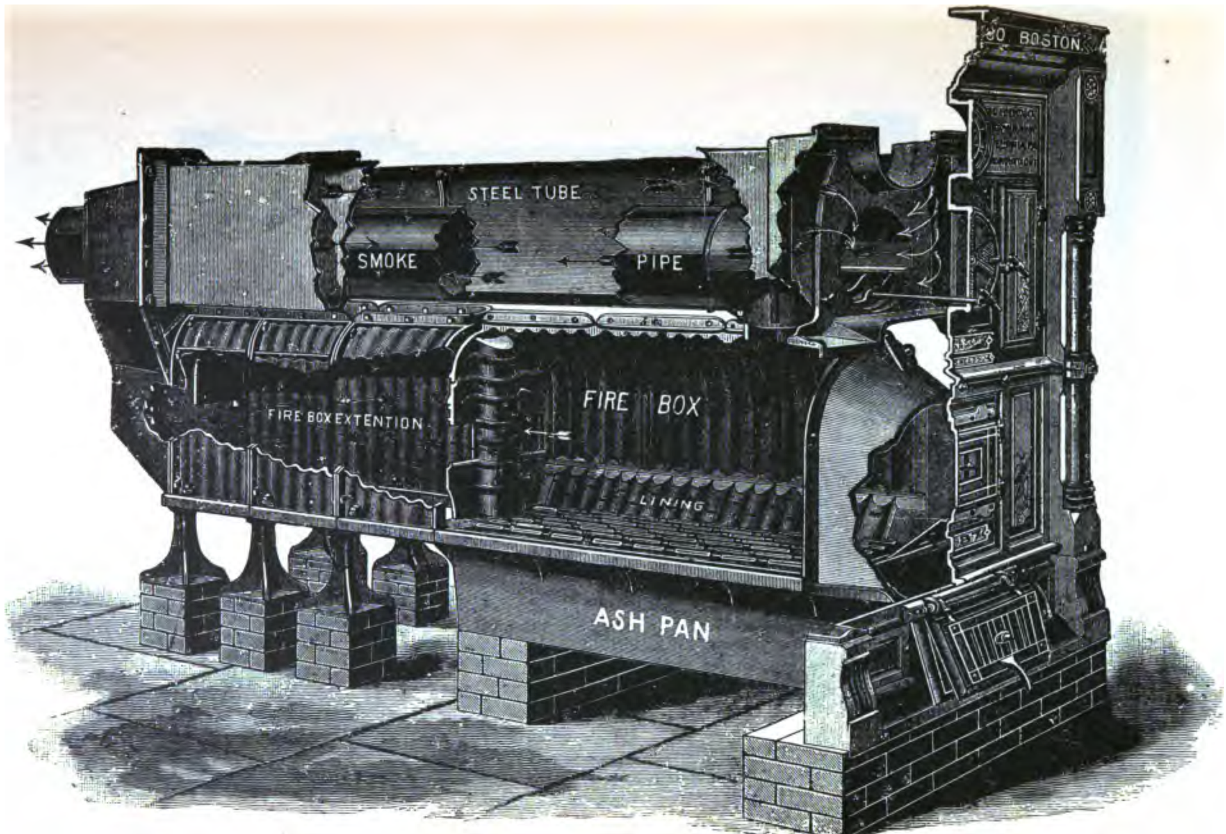


Fig. 67.—Interior view of air-warmer.

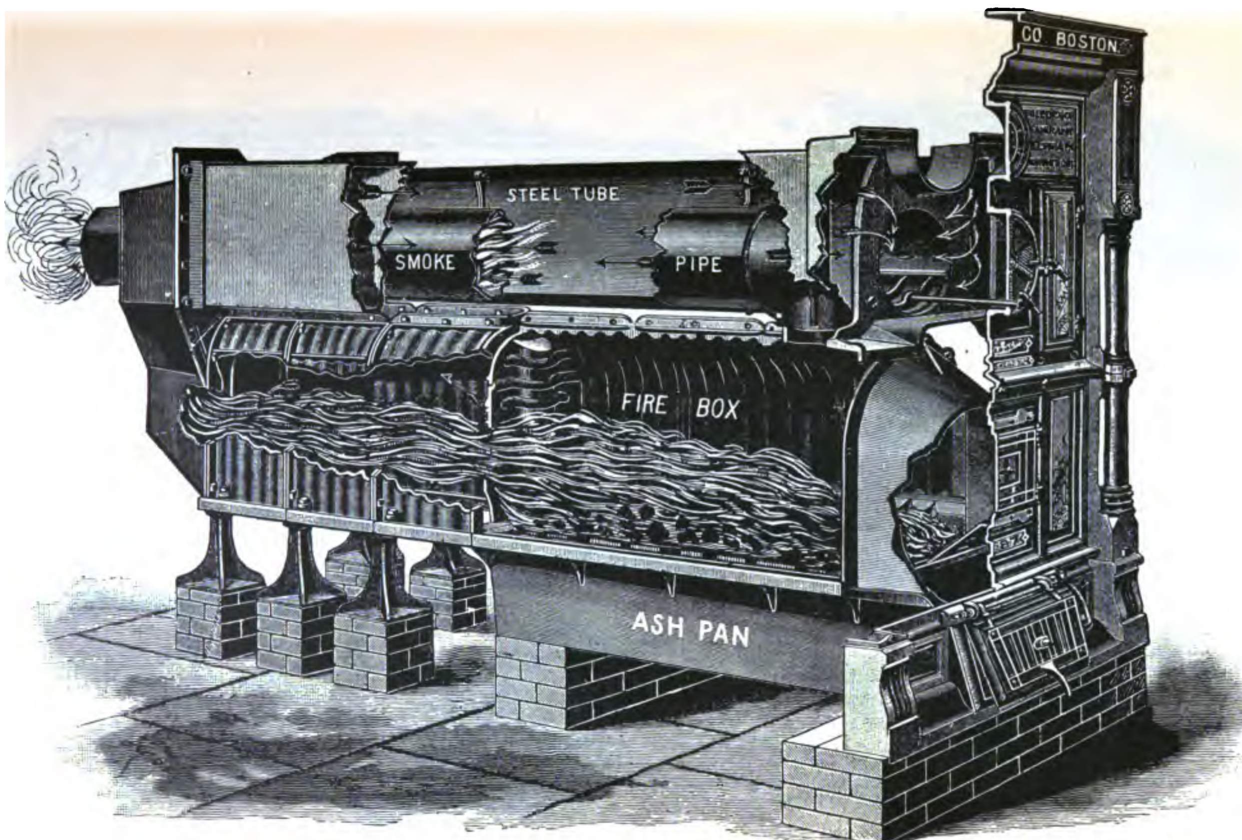


Fig. 68.—Interior view of air-warmer, showing fire.

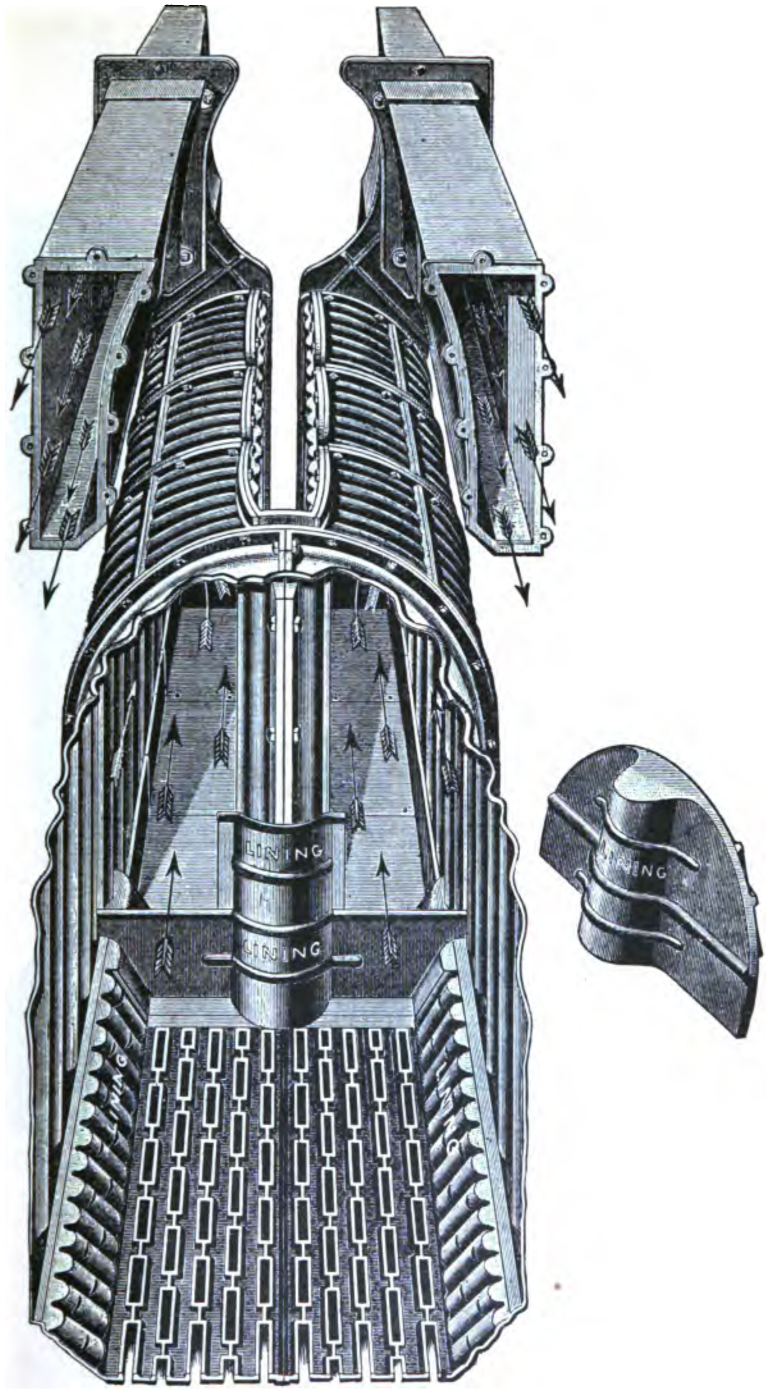


FIG. 69.—View of air-warmer with front portion cut away, showing interior of fire box, grate, linings, rear extension, etc. [The air circulates around the warmer, up the center of the rear extension, and around the three smoke flues.—A. P. M—.]

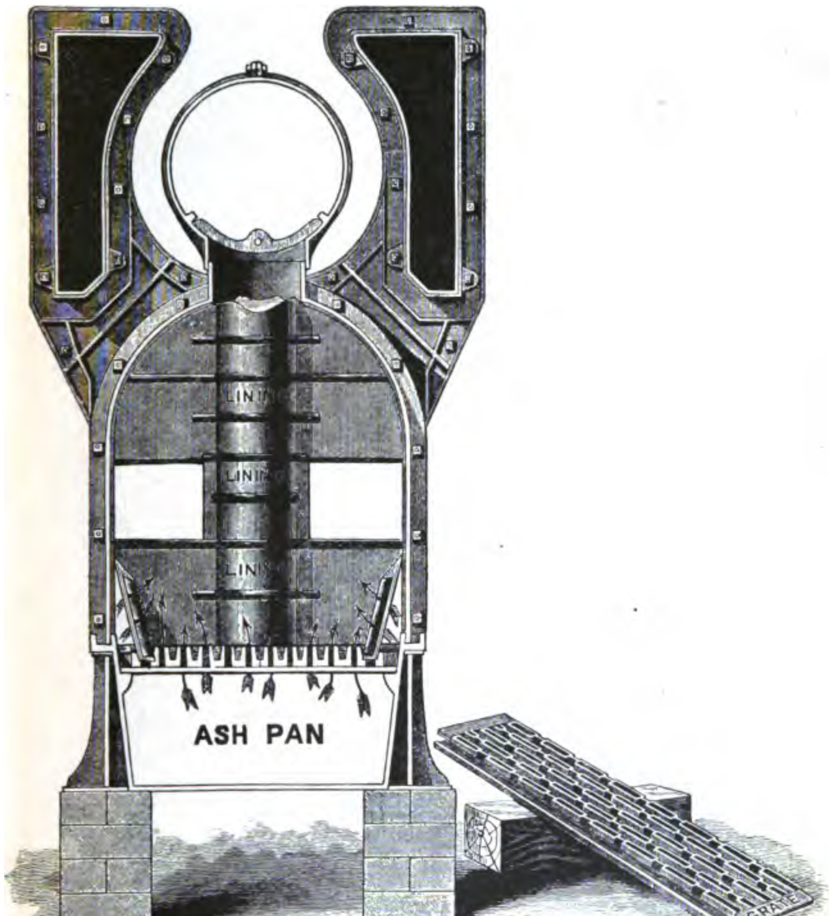


Fig. 70.—Sectional view of air-warmer, through steel flues, smoke pipe, fire box, ash pan, and patent grate.

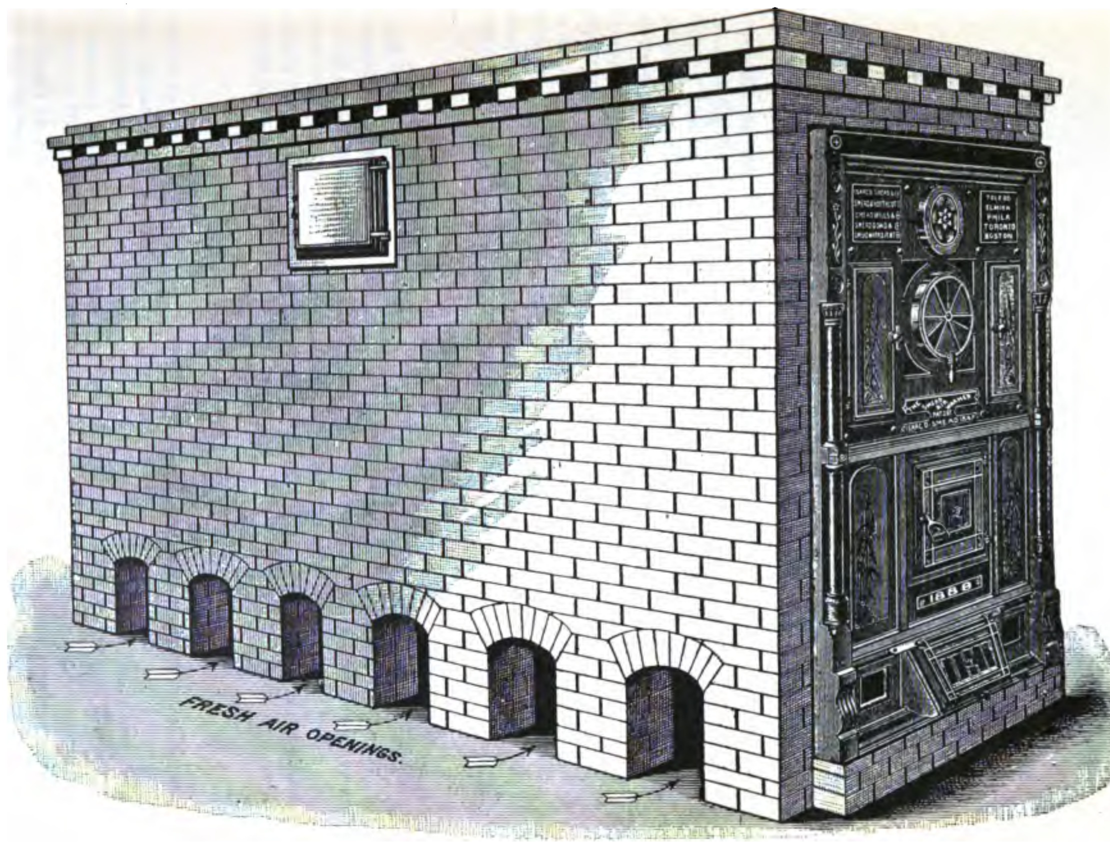


Fig. 71.—The air-warmer, with brick case.

APPENDIX I.

A SYSTEM OF VENTILATION FOR SCHOOLHOUSES HEATED BY STOVES AS APPROVED BY THE MASSACHUSETTS STATE INSPECTION DEPARTMENT OF FACTORIES AND PUBLIC BUILDINGS.

In the enforcement of chapter 149, acts of 1888, "An act to cause proper sanitary provisions and proper ventilation in public buildings and schoolhouses," throughout the State, I find by the reports of the inspectors that most of the schoolrooms outside of our large cities are heated by stoves and that any special system requiring heated flues is not applicable. To arrive at some conclusion as to what system should be recommended for this class of schoolrooms has been the subject of careful consideration, and it has been found that the best means thus far devised for ventilating rooms heated by stoves, that approximates a good system of ventilation, is the "jacketed" stove. By the courtesy of the secretary of the State board of health I am enabled to give a description of the system adopted at the Red Rock street schoolhouse, Lynn, and to copy a portion of the report made by Dr. J. G. Pinkham.

USE OF JACKETED STOVES.

It may be taken for granted that it is impossible to supply schoolrooms with the large amount of fresh air required for proper ventilation and at the same time to keep up the temperature, unless provision is made for warming the air before or during its introduction. To accomplish this economically with the class of rooms under consideration, the jacketed stove, or some form of heater arranged on the same principle, seems to be the only available device.

RED ROCK STREET SCHOOLHOUSE, LYNN.

This is a brick building of good construction and in a healthy locality. The ventilating apparatus was put into it during the summer of 1886, and the description which follows is from the report of the committee on sanitation for that year:

"There are in each room two large stoves (Barstow's Puritan, No. 18), one on each side of the room, near the front. Each stove is incased in a galvanized-iron jacket about 6½ feet high with a spreading base. Air is admitted to the space between the stove and its jacket by an air-box running through the side wall, the opening for each stove having a sectional area of 4½ square feet, being large enough for the whole air supply of the room. In cool weather one stove in each room is used; in cold weather both stoves.

"There are two extraction flues, built in one stack, at the rear of the building, one with a sectional area of 5.2 square feet for the upper room and one with a sectional area of 4.1 square feet for the lower room. They are of brick, and in an inner corner of each is a fire-clay smoke pipe connecting with the stove pipes. These smoke pipes end at the level of the chimney top, and the whole is covered with an iron cap like an Emerson ventilator, but rectangular. For heating the flues one of

D. W. Cushing's Ring Cylinder stoves is set into the *with*, or partition between the flues, projecting into each. The flues are enlarged opposite the stove to compensate for the obstruction of its bulk. As the cellar does not extend under the rear of the building the flues end at the floor level of the lower room. The openings from the rooms into the extraction flues are made at this level from the lower room directly through the wall, and from the upper room by means of a 30-inch tin pipe running down beside the stack from the upper floor. The flue-heating stove is set about 3 feet above the lower floor, and access to it is had through an iron door opening into the schoolroom. Most of the air withdrawn from the rooms goes through large openings close to the stack; the remainder (15 or 20 per cent.) is drawn through ducts under the back platform, and thence into the extraction flues. The total area of outlet openings from each room is about equal to the sectional area of its extraction flue. All outlet openings are covered with wire netting of about 1-inch mesh. Inlets on outside of building are protected by boxing and fine netting."

The illustrations which follow will make this description plain. All dimensions are given in the floor plan and sections. The capacity of the lower room is 10,700 cubic feet, that of the upper 12,040 cubic feet, allowance being made for chimney, platforms, stoves, and jackets, but none for furniture or persons. The air space per scholar, using the average attendance during the winter term of 1886 as the basis of calculation, is for the lower room 194 cubic feet, for the upper room 240 cubic feet. The actual air space enjoyed by each pupil in any school varies, of course, from time to time with the number in attendance. The average age of the pupils in the lower room is 7 years 9 months; in the upper room, 9 years 6 months. The results at this schoolhouse have been most excellent. There was no difficulty in managing the apparatus after its working was fully understood.

Visitors to the school note the apparent purity of the air and the teachers bear similar testimony.

Measurements of the outflowing air have been made at various times. These show an average for the lower room of 108,510 cubic feet per hour, or about 2,100 cubic feet to each pupil; for the upper room 84,664 cubic feet, or about 1,900 cubic feet to each pupil. In making these estimates the cubic contents of the rooms were added to the outflow, and the average attendance of the pupils employed as a factor.

It is probable that in mild weather these figures would be somewhat reduced. They might be considerably reduced and still leave quite a liberal supply for pupils of the ages specified if the commonly received views as to the amount required are correct. It is intended that the fire shall be kept burning in the flue-heating stove at all times except in warm weather. In this way the air supply may be kept up when the jacketed stoves are not in use.

The air analyses have very uniformly shown good results.

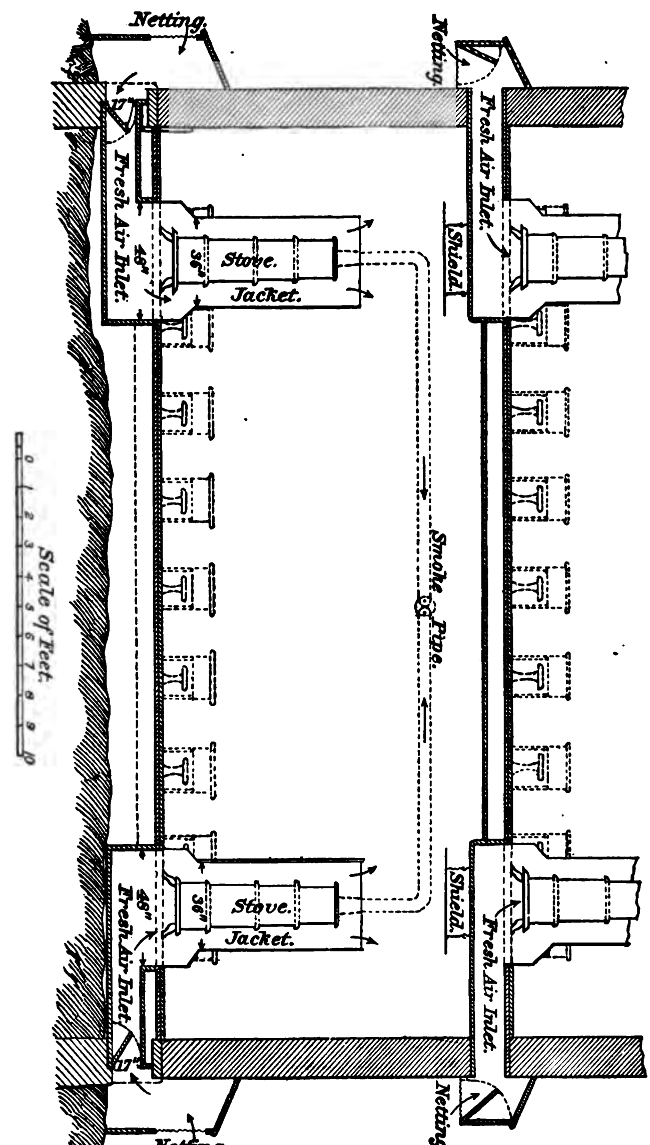


Fig. I.—Red Rock Street Schoolhouse. (Section through heating stoves and fresh-air inlets.)

Note.—If the Bridgeport experiments (*see* Appendix II) are correct, as is believed, a more complete change of air in this room would be secured by placing the stoves at the same end of the room as the chimney. The unsightly stovepipe would be avoided, and its dripping, its rusting, and its frequent removal would be saved. The heat from this long pipe would be lost to the room, of course, but it would be utilized in the ventilating flue, and thus save the extra fire in the chimney stove part of the time. With the ventilating chimney at the rear of the front platform, the stove in the flues could be fed from the landing of the stairs, and additional windows could be paced in the rear wall. In this plan there should be more windows at the left of the pupils. Those at their right should generally have the blinds closed.—[A. P. M.]

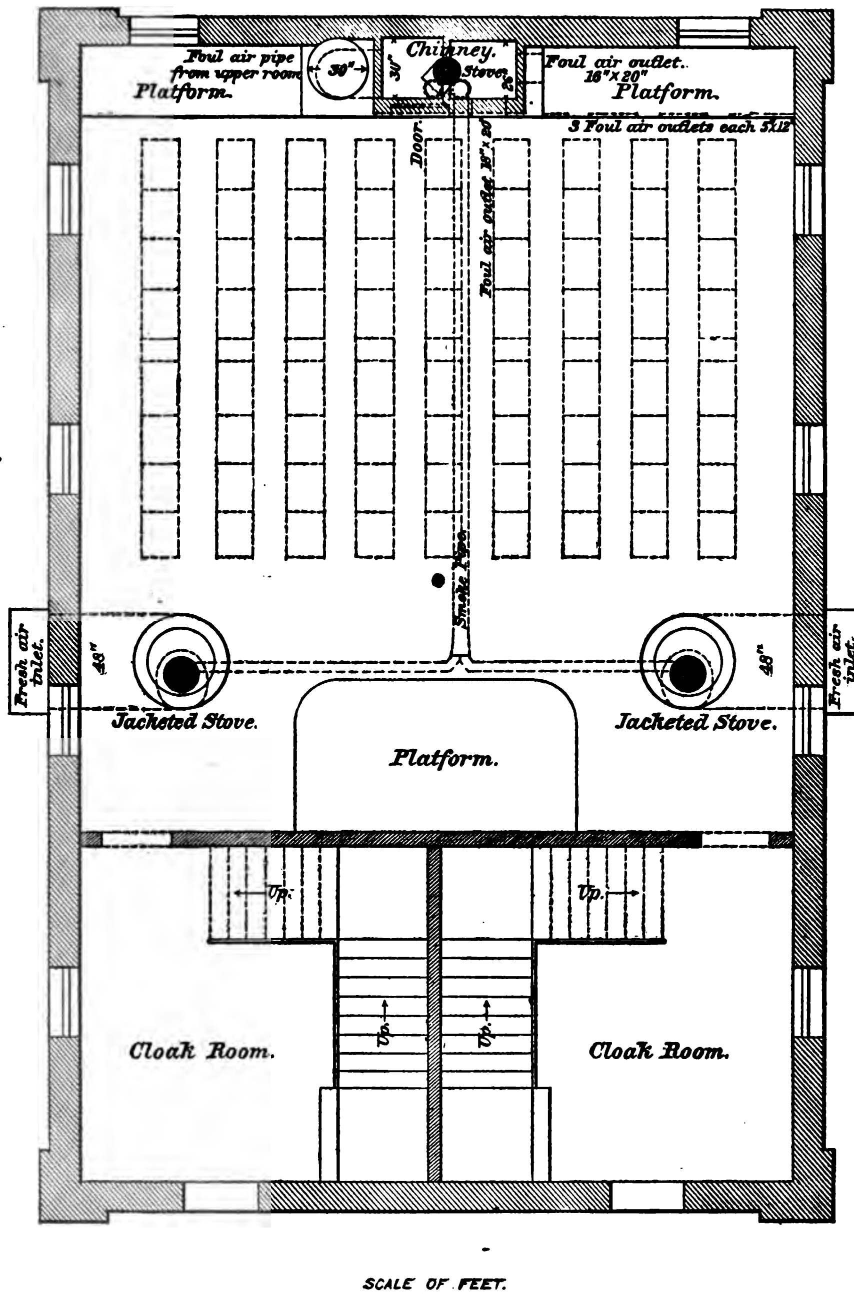


FIG. 2.—Red Rock Street Schoolhouse. (Lower room; front plan.)

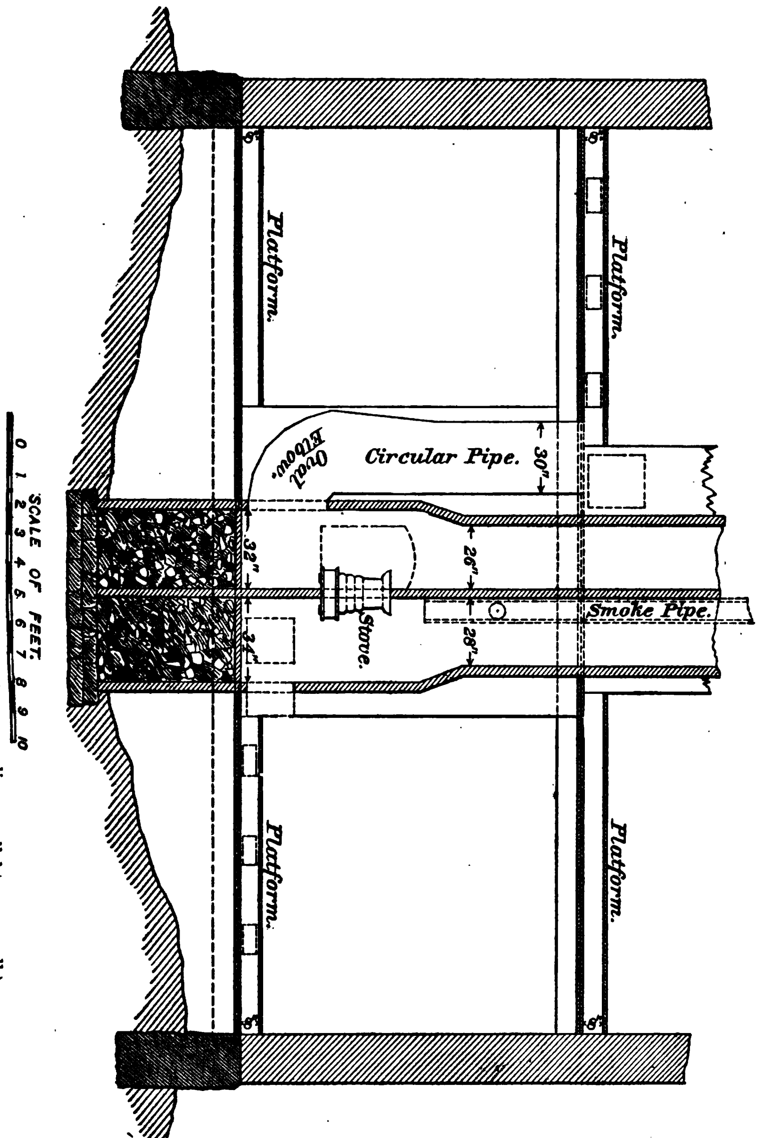


FIG. 3.—Red Rock Street Schoolhouse. (Section through chimney on line parallel to rear wall.)

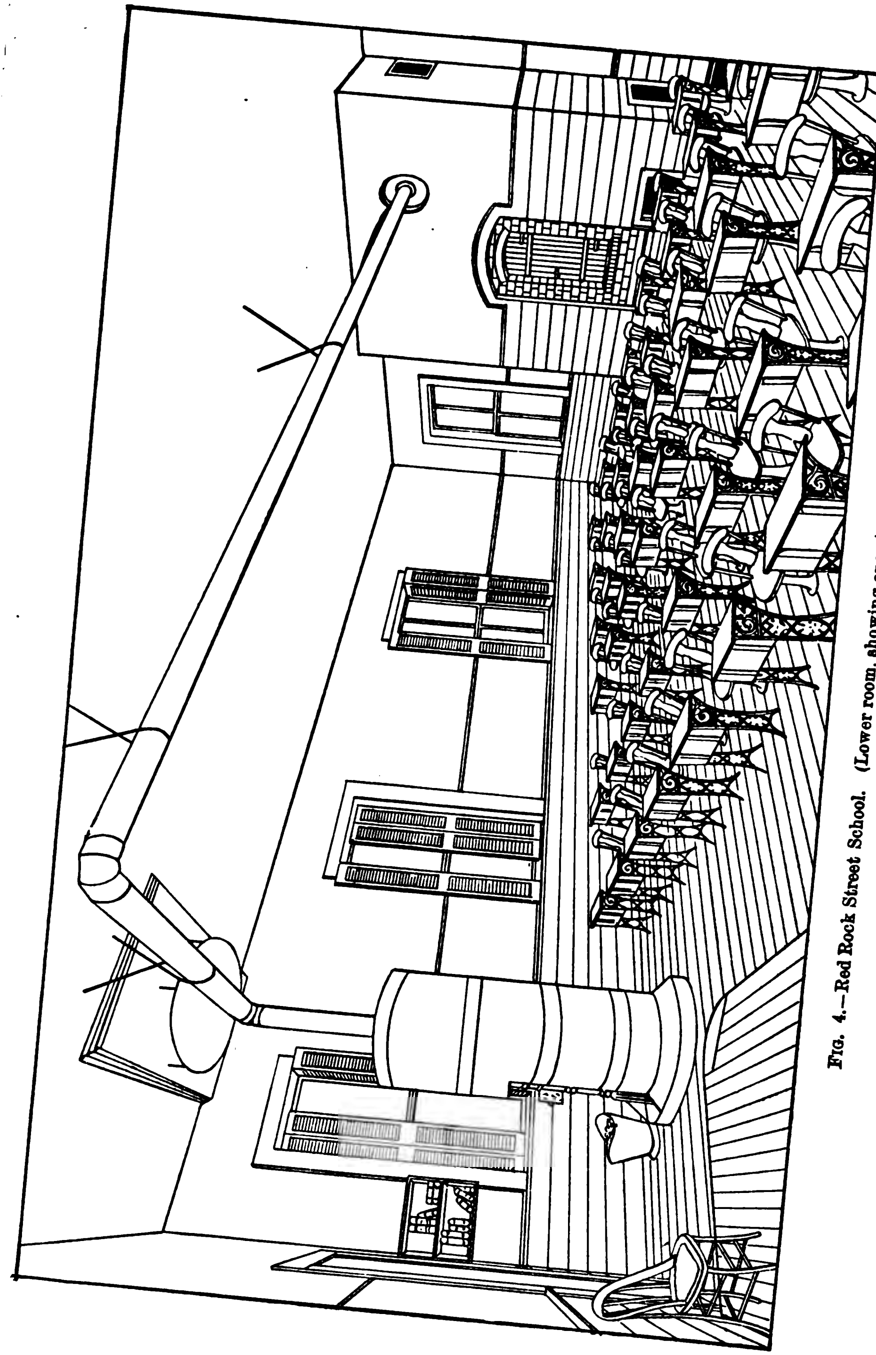


FIG. 4.—Red Rock Street School. (Lower room, showing one stove. See note, p. 69.)

APPENDIX II.

THE HYGIENIC CONSTRUCTION OF THE BRIDGEPORT HIGH SCHOOL BUILDING.

By Warren R. Briggs, Architect, Bridgeport, Conn.*

In no department of public or private works is there such vital necessity for a perfect system of hygiene as in the planning, construction, drainage, and ventilation of our school buildings. At no time in our lives are we so susceptible to disease as in our school days. The rapid growth of the child, the mental strain that our forcing system of education requires, and the bad sanitary condition of many homes, all tend to weaken the constitution at this period, and render it particularly liable to the contraction of disease. The necessity of abating, as far as possible, and ultimately exterminating, what is known as preventable disease, has become of paramount importance. The alarming spread of malarial diseases and malignant epidemics among children in various parts of the country I attribute, in the majority of cases, to criminal carelessness in sanitary matters. Miserable construction, poor sewerage, bad plumbing, and no system of ventilation, combine to produce among the poor classes hotbeds for the nursing of the germs of pestilential disease that are then conveyed by the children to our schoolhouses. Much has been accomplished by our State and local boards of health to remedy this evil, but there still remains a vast amount of work to be done. Stringent legislation is needed in all matters pertaining to building, and proper officers appointed by the Governor to enforce the laws are required in all the larger cities of our State. When this is done we may hope to see the erection of the miserable shams, that greedy speculators and unscrupulous landlords now burden us with, stopped. So long as they enjoy the license at present allowed them, we can hope for no improvement.

The schoolhouse, where the child spends from four to six hours each day, demands our direct attention. The majority of the pupils in our public schools come from the poorer classes, and are, as a rule, none too cleanly in their personal habits. Coming from homes which have none of the luxuries and barely the necessities of life, they are in no condition to be subjected to either excessive heat or extreme cold. Foul air and poor ventilation they have in plenty at their homes, and we should endeavor in the schoolroom to supply them with pure air, uniform temperature, plenty of sunlight, cheerfulness, refinement, and comfort; our buildings should be so planned as to combine all these requirements.

Dr. Lincoln, in his admirable paper recently published in Buck's Hygiene, has plainly told us what a school building should be, and the writer has endeavored, as far as lay in his power, to produce a building that shall be a model of its kind. He has not only labored long and faithfully himself, but has consulted the leading experts of the country in regard to the heating, ventilation, and general sanitary arrangements of the building, and has always received from them their hearty approval, coupled with the remark: "We have frequently called the attention of the public in our articles to what a building should be, and we are glad to see at last a building planned in accordance with our views."

* Reprinted by courtesy of the author and the State Board of Health.

In all the writer's efforts he has been most ably seconded by the board of education of this city, and more especially by the members of the board who comprise the building committee. They are, to a man, whole-souled, enlightened, Christian gentlemen, who have the welfare of the public in view, and although they have been severely criticised and wrongfully assailed, they have unflinchingly put their shoulders to the wheel, and worked with a zeal that can not be too highly commended to secure for the city a building that can be pointed to with pride when finished.

The site of the new building is admirable. Situated almost in the geographical center of the city, in one of its best localities, far removed from all noise, dust, or odors arising from factories, stables, or the like, being completely isolated on all sides, having no large buildings or trees to shadow it, and standing within a few feet of the highest ground within the city limits, it presents natural advantages that have never been surpassed, and seldom equaled. The lot has an actual elevation of 61 feet above the average high water in the harbor. It has a frontage on two streets of 200 feet, and an average depth of 256 feet, the lot running from street to street. Not only are great advantages obtained by this frontage in ease of access to the building, but thus are secured unexceptional facilities for the disposal of sewage, there being a 12-inch main running down the hill in the center of both streets. In these streets the fall is very rapid, between 4 and 6 feet in every hundred.

The principal front (there is no rear) of the building faces Congress street, which, running nearly east and west, gives it a southwesterly exposure. This arrangement secures in every room in the building, during a portion of the day, *sunlight* in abundant quantities.

The building is designed to be constructed of brick, with local stone foundations and underpinnings, brownstone caps, sills and trimmings, exterior steps to be of granite, and roofs of slate. It will consist of three stories, viz, the ground floor, first story and second story. It contains a total of fourteen school and recitation rooms, a chemical laboratory, reception room, office, library, janitor's room, work and boiler room, besides the water-closets.

The height of all rooms in the building, with the exception of the high school room, is 13 feet, the high school room having a height of 28 feet in the center, and 21 feet on the sides.

The writer does not consider it necessary to go into a detailed explanation of each floor plan, but will simply call attention to some of the novel features and general construction of the building. The plans themselves illustrate sufficiently the general position and arrangement of rooms and halls.

The ground floor is located two steps, or about fifteen inches, below the grade of the lot. This, under ordinary circumstances, would be considered an objection, on the plea of dampness, but the floor and side walls have been so carefully prepared that the rooms situated on this floor are expected to be the driest in the building.

In the first place, the ground itself is unusually free from dampness. Ample provision has, however, been made for the removal of all surface water by the introduction of 6-inch drain pipes, laid with open joints in trenches filled with loose stone, the stones covering the top of the pipe a few inches. These pipes run all around the building, just outside of the foundation wall, and are then carried to the manholes, where they are connected with the main sewer above the running trap.

The ground under the floor of the schoolrooms situated on the ground floor is first cemented 2½ inches with the best Rosendale cement, and then covered with two coats of asphaltum. This asphalt is put on hot, and not only covers the entire bottom, but runs up on all outside and inside walls to the height of the copings, and is then carried across the top of all interior and exterior walls, forming an impenetrable protection against dampness. Not only are the ground floor and the walls to the height of the coping treated in this manner, but all outside walls in the building,—they are all coated to their full height and width with two coats before they are furred. This I believe to be a more perfect safeguard against dampness than the hollow wall.

STAIRCASES.

The staircases consist of four flights; two at either end of the building. While being convenient and easy of access from all parts of the building, they are yet sufficiently isolated to be free from the usual objection of noise, and are moreover absolutely fireproof. They are constructed with iron treads and risers securely fastened to stringpieces, also of iron, that are bolted directly to the brick inclosing-walls. The top surfaces of all treads are to be covered with rubber, to prevent slipping. All platforms and landings are to be formed of granite slabs 8 inches thick. The stairs are formed with two "runs" for each flight, with landings midway, this being done to secure an easy ascent. The stairs are all 5 feet wide; all landings, 5 by 11 feet; risers, 7½ inches; treads, 11 inches; they are well lighted at all points by ample windows placed on each landing. An iron hand rail, bolted to the walls, runs around on all sides at a suitable height. There is no wood finish of any kind, with the exception of door and window casings, in the staircase halls. The side walls are all of face brick laid in black mortar with struck joints. These walls, when hard, are to be treated with a coat of liquid filler, and then varnished in two coats, thus forming a perfectly hard surface not easily marred or soiled.

HAT AND CLOAK ROOMS.

In all our school buildings of the present day, the hat and cloak rooms have been more or less objectionable, especially in wet weather. Children coming in with wet garments hang them in narrow rooms, poorly heated and lighted, and usually unventilated, where they are allowed to steam in a close and unwholesome atmosphere during the session, and at its close are put on by the child in a worse condition than when taken off. An attempt has been made to remedy this evil in the construction of this building. In the main halls, which are spacious, and which are to be heated and ventilated in the same manner as the schoolrooms, have been placed the hat and cloak rooms—two for each schoolroom. These rooms instead of being lathed and plastered in the usual manner are simply partitions of ash 8 feet high, entirely open at the top, and so arranged that only the supporting-posts run down to the floor. The portion of the partition between the posts is kept 4 inches from the floor, giving a free circulation of air throughout the rooms. Damp or uncleanly clothing hung in these rooms during the session instead of being filled with foulness arising from the confined atmosphere will become purified by the constant circulation of pure air, the impure air being disposed of through the main hall ventilators.

LIGHT.

All eminent writers on school hygiene have called attention and dwelt with much stress upon the importance of abundant light properly distributed in our school rooms. That the light should come from the left side and be introduced at nearly right angles to the floor-line is an established rule among those versed in school matters. Upon the actual amount of glass required by each pupil authorities differ. Dr. Lincoln states that the size of the windows, taken collectively, should equal at least one-sixth of the floor space. Cohn, the German writer, requires one-fifth, or 30 inches to the foot. Some of the highest authorities require from 300 to 350 square inches of glass for each pupil. This coincides very nearly with Cohn, but Dr. Lincoln does not consider that in our schoolrooms that have a greater depth than those referred to by the above-mentioned authorities, the amount mentioned by them is enough.

In the Bridgeport schoolhouse the window-stools have all been kept 4 feet from the floor, and the window openings are carried up to within 1 foot of the ceilings. The size of the windows, taken collectively, equals, in the corner rooms, one-sixth of the floor-space, allowing 50 pupils per room, and provides 434 square inches of glass per pupil. In the middle rooms the floor-space is seven times that of the glass surface, and allowing 50 pupils per room will give to each 403 square inches of glass.

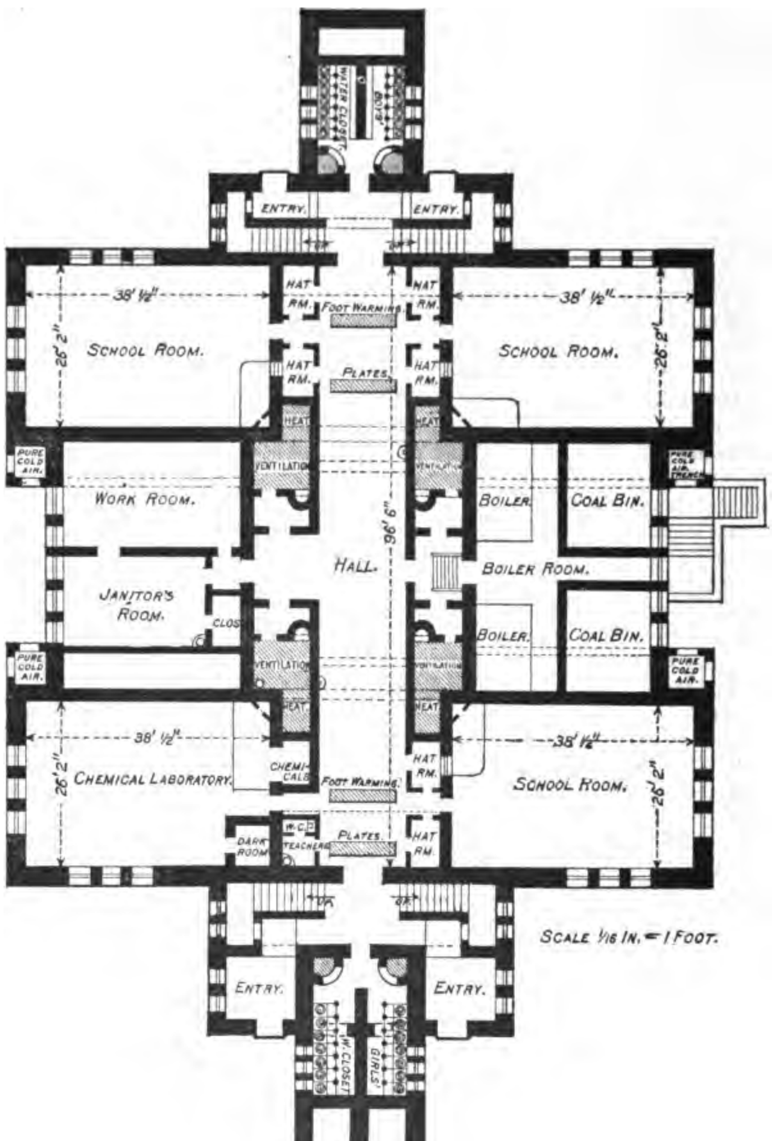


FIG. 1.—Bridgeport High School building. (Ground plan.)

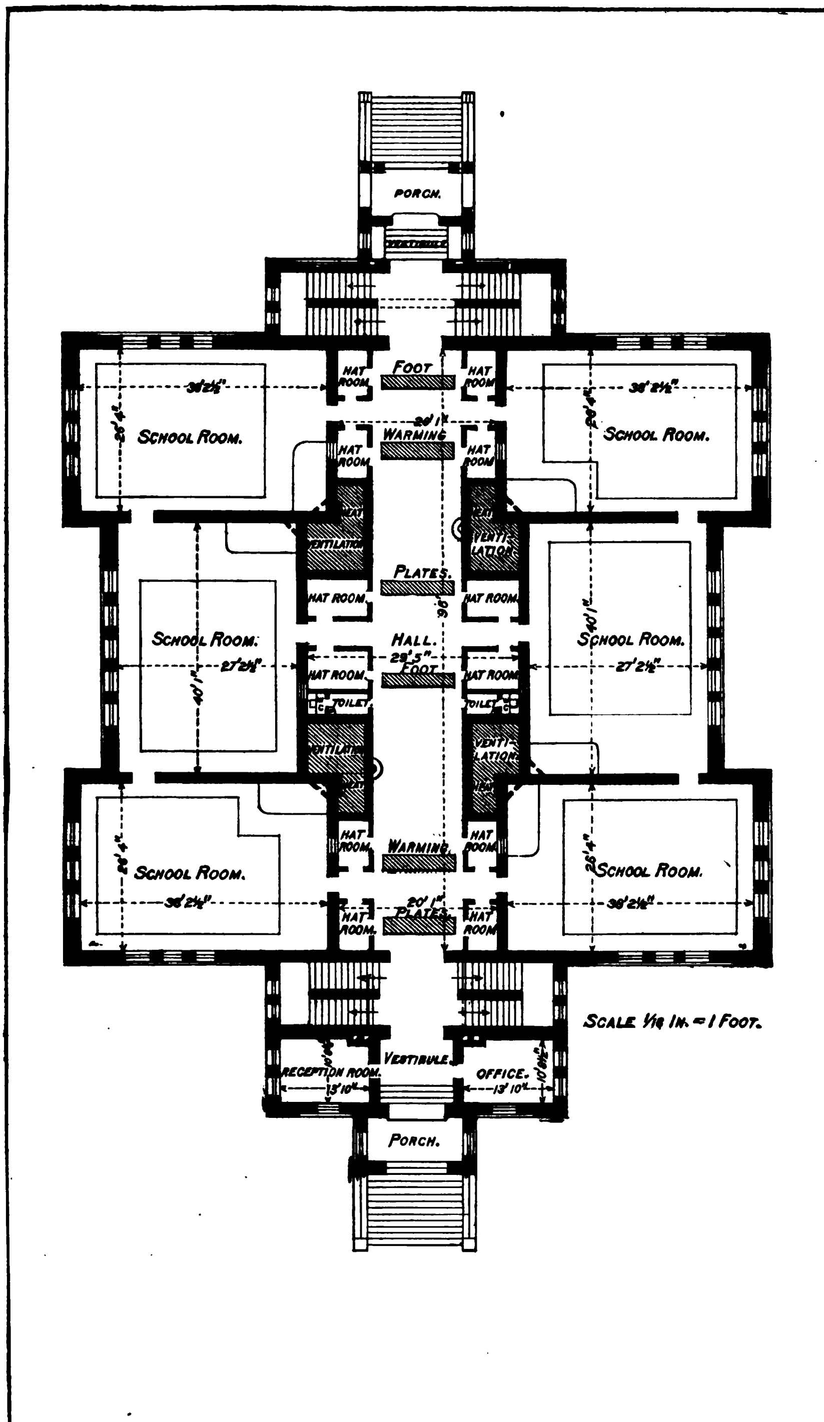


Fig. 2.—Bridgeport High School building. (First-story plan.)

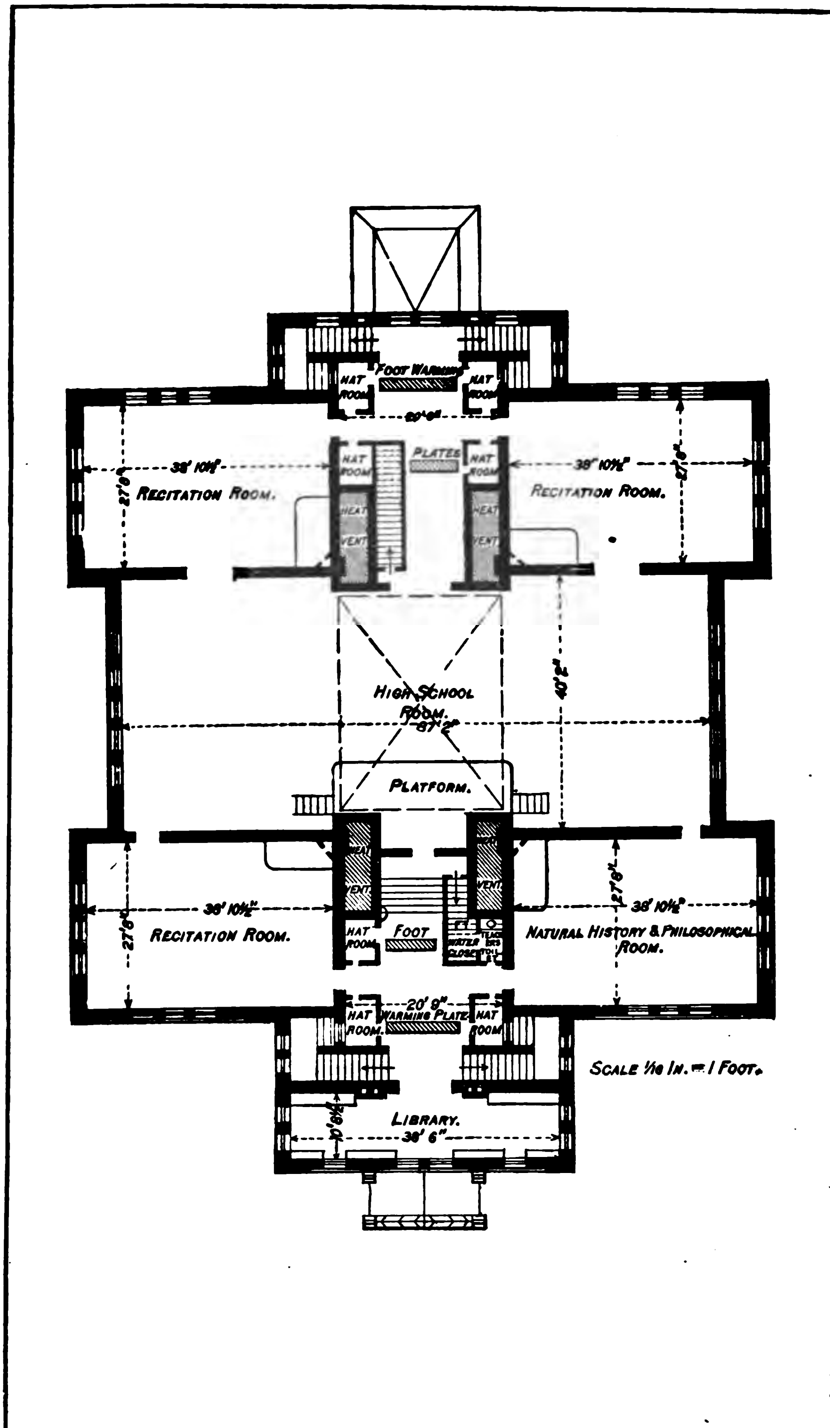


FIG. 3.—Bridgeport High School building. (Second-story plan.)

In the corner rooms the seats are so arranged that the light comes always from the back and left; in the middle rooms it comes only from the left.

In the High School room the glass surfaces, taken collectively, equal one-sixth the floor-space; allowing 200 pupils for this room will give to each pupil 384 square inches of glass surface.

FLOOR, AND CUBIC FEET OF SPACE ALLOWED EACH PUPIL.

In the corner rooms, allowing 50 pupils per room, each pupil will have 20.50 square feet of floor-space and 266 cubic feet of air. In the middle rooms each pupil will have 21 square feet of floor-space and 273 cubic feet of air. In the High School, allowing 200 pupils, each pupil will have 17 square feet of space and 441 cubic feet of air. While the floor-space in the High school room is somewhat smaller than the highest authorities require, the cubic contents are largely in excess of the most exacting, and it must be taken into consideration that this room is seldom occupied by the entire number of pupils for more than a few moments at a time, as the recitation rooms used in connection with it are, during the school session, in constant use. It should also be remembered that the number of pupils calculated for each room is their extreme capacity. It is to be hoped that no teacher will be burdened with more than 44 pupils, although I have based my estimations on a larger number.

THE WATER-CLOSETS AND THEIR CONSTRUCTION.

The demands of modern civilization require that we provide, either within our school buildings or in close proximity to them, water-closets for the use of the pupils. There can be no doubt but that much harm is done to children, in many schools in our State, from the bad sewerage and careless arrangement of water-closets. It has been said that privies placed under the same roof which shelters the school should not exist for a moment. I do not consider that this rule should be simply applied to privies, but that the groups of water-closets that are required in all our large schools should come under the same head; they should in no case be placed directly under schoolrooms in the basement, as contamination will surely follow sooner or later. They should be, if not wholly, at least partially isolated from the building, and those for the boys removed as far as possible from those of the girls. The teachers' water closets can, I think, with safety be placed in the building, that is, if they are carefully ventilated; these water-closets will be used understandingly and are not liable to become unwholesome, but the pupils' closets, even with the most careful watching, are liable to become foul from the habit so prevalent among children (I wish I could say that the habit was confined to children alone) of making the closet a common receptacle for all kinds of garbage.

In the Bridgeport schoolhouse the closets for the pupils have been placed at either end of the building, under the entrance steps, far removed from each other, securing a complete isolation of the sexes. They are also completely shut off from the main school building by the intervening staircase halls; by this arrangement, ease of access is obtained, combined with complete isolation, obviating the danger of contaminating the main school building.

The water-closets have been constructed with a view to having as little woodwork as is possible with the requirements of comfort. The main floor is to be of bluestone flagging 4 inches thick, laid in Portland cement; this is laid on a gentle incline to a certain point, to secure a good dip or wash from all points of the room. The side walls are of brick, treated in the same manner as has been before mentioned in the description of the entrance halls. The ceilings will be formed by the bottom of the granite slabs that are used for the floors of the vestibule, porch, and outer halls. The casings, doors, and seats for the closets comprise the entire woodwork; these are of ash and are treated to a coat of filler and then varnished in two coats. The partition between the hoppers is to be of slate 1½ inches thick, 7 feet high by 2 feet 6 inches broad. These slate partitions are held in position by iron floor and wall pieces and caps of the same material (see accompanying drawings). The floor upon which the hoppers stand is raised one step above the main floor of the closet (see drawing), and is also composed of bluestone flagging 4 inches thick, a hole being cut through this stone for the outlet of the hopper. The closet that is intended to be used is the Hellyer Short Artizan Hopper. This closet combines more good points, in the writer's opinion, than any at present known to him. Its chief point of excellence is its simplicity of working, and the fact that it is entirely of earthenware. There are no pans, valves, or plungers to become foul or get out of order; it is, in fact, an earthen hopper of improved shape, fed by a continuous tank to which is attached for each bowl a serving box. When the seat is occupied, by a simple device a valve is raised, and the serving box filled with water from the tank, at the same time a small stream is permitted to trickle into the hopper, wetting the sides and preventing the adhesion of excretion to the bowl. When the seat is relieved of its weight, the valve before referred to is closed, another one opened, and the contents of the sei ving box (some

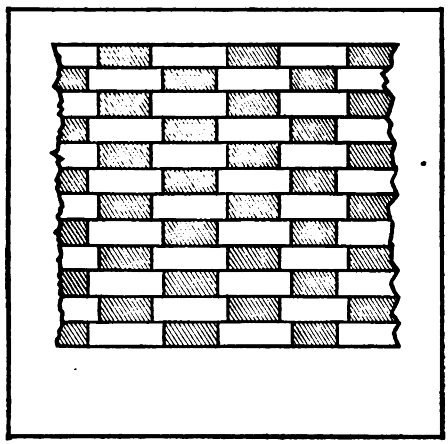


FIG. 4.—Method of laying brick around stoves in water-closets

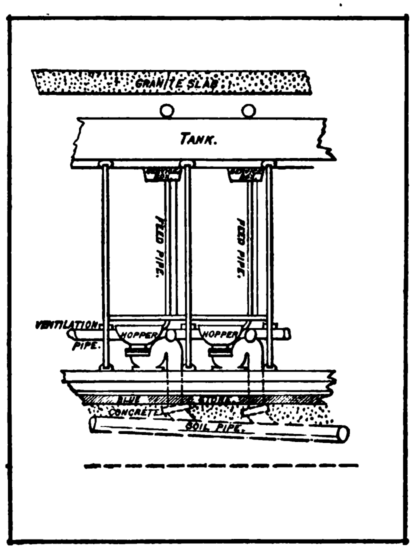


FIG. 5.—Elevation of a portion of the closets.

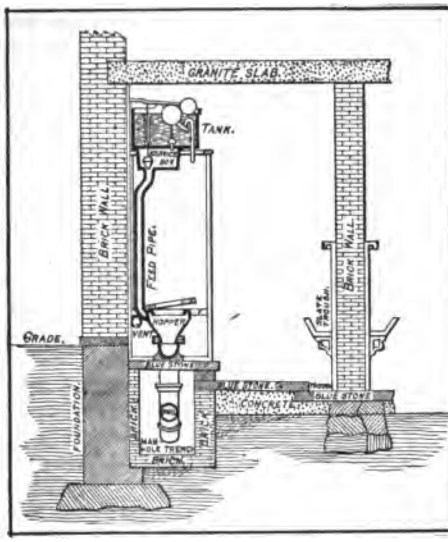


FIG. 6.—Section through water-closet.

3 gallons) suddenly discharged through a large pipe connected with the flushing rim into the bowl of the hopper, carrying all solid matter through the trap. As I have said before, these hoppers, both bowl and trap, are of white earthenware; they are to be securely bolted to the bluestone and left entirely open and exposed to view. The seat is supported by the slate partitions, on which are bolted slate cleats. The chain operating the service box and feed pipe are both inclosed in an iron pipe, so as to be completely inaccessible to the pupils.

The tank and service boxes are of iron, painted. Directly under the platform on which the hoppers stand, there is to be constructed a manhole trench, to be built of brick, coated with asphalt; the top is formed of the bluestone that the hoppers rest upon. This manhole is 2 feet broad by 3 feet 6 inches high, and is large enough to permit a man to crawl through it to inspect the pipes. This trench is to have an iron register at one end for the admission of pure air, and at the other it is connected directly with the ventilating shaft. In this trench are to run the soil pipes from the hoppers; these are to consist of 6-inch cast-iron pipes with a 4-inch Y-joint for each hopper. These pipes are calked with molten lead and then covered with two coats of asphaltum to prevent rust. By the arrangement of this trench the soil pipe and its connections are always accessible; even should a leak occur in any of its joints that was not at once discovered, the stench arising from such a cause would not enter the building but pass off through the ventilating flue. The urinals are placed along the inside division walls; they are to be constructed with slate backs and troughs put together in the most approved manner, the trough being supported by brass brackets; the back is arranged with a neat cap of slate, under which is run a water pipe perforated with small holes so as to secure the complete wetting of the entire back at all times. Underneath this trough, in the floor, there is another trough, the bottom and one side being of bluestone and the other formed by the slate back; this trough has an inclined surface and is intended to carry off all drippings or sloppings that may occur in or about the closets or urinals. At its outlet it is trapped with a deep running trap and then connected with the main drain. This arrangement will enable the janitor, at the close of each day's session, thoroughly to wash down with a hose the entire room.

Upon the inside walls of the rooms that are occupied by the closets have been placed ventilating flues, two for each of the closets. These flues are of large size, and run up through the building, entirely independent of all other flues, to a point far above the main cornice line. Through these flues the extension of the soil pipes of each section of hoppers is carried, and there is also connected with the flues a vent pipe, running under the seats just above the trap of each hopper. Lastly, the trench in which the soil pipe runs is also connected. The lower portions of the flues, that is, those parts of them that come directly into the rooms occupied by the water-closets, are enlarged into a circular form (see plans), this being done to permit of the introduction of a small stove in the bottom of each flue, and this stove is to be kept running always, both winter and summer, as the writer believes that this is the only way to secure a steady up-current at all times under the varying conditions of the atmosphere. The brick work around the stoves is laid in open work (see sketch), and on the inside covered with wire netting. There is also an iron door provided for each flue. By this arrangement many points are gained; not only are the hoppers and soil pipes perfectly ventilated, but any stench arising in the rooms is quickly removed by the strong up-current through the flues. Again, in the winter, the stoves, two in each room, will be ample for heating purposes, while in summer, by a simple device, the direct radiation is shut off from the room and thrown entirely up the flue.

The teachers' water-closets, situated two on each floor, are to be of the same pattern as those described, fitted up in the same manner as the ordinary house closets, but with special reference to their construction and ventilation.

NOTE.—The soil pipes for the teachers' closets in the main building are laid in a trench in the same maner as described above; the main drain runs into a manhole just outside of the building, where the three lines of soil pipes (one from each section of hoppers, and one from the teachers' closets) are brought together just above a deep running trap. This manhole is covered with a bluestone flag, is carefully ventilated, and easy of access. There is also connected, just above the trap in this manhole, the rainwater drains connected with the leaders from roof, so as to secure during every rain a thorough scouring out of all the drains and their connections. The reader, by studying the accompanying plans and sketches, will be enabled readily to understand the general arrangement and working of this system.

HEAT AND VENTILATION.

It is generally admitted, on all sides, that the most practical, economical, and surest way of heating our buildings, at the present day, is steam. Granting that steam is to be our medium, it next becomes a question of how it shall be used. There are, at this writing, two methods in general use, these being known respectively as the direct and indirect systems. The direct system means the placing of radiators or circulation pipes in each and every room required to be heated. The indirect system consists in placing all the pipes or radiators in boxes in the basement. Pure, cold air is brought into these boxes, and by passing through the coils of heated steam pipes is warmed to the degree required. The heat generated in the boxes is then conveyed to the various rooms through tubes or pipes, in the same way that heat is usually conducted from our hot-air furnaces. Both systems have many strong advocates, but as far as the writer's investigations and researches have led him, he has found, among men that have simply the heating of a room in view, the direct system in favor; but among those who desire not only the actual heating, but the supplying of the room with fresh, pure air at all times, the indirect system is invariably adopted. From the personal investigations and practical experiments the writer has made from time to time, he is convinced that far better results can be obtained by the indirect method than by any now known to him. It has therefore been adopted in the new building for this city. It may be said in objection to this system that the amount of fuel required to heat a given amount of space is largely in excess of that required by the direct plan; this is in a measure true, but not to the extent supposed. Again, it has been said that it is impossible to heat exposed rooms by the indirect plan, without an enormous apparatus. This also is a mistake, for neither an extravagant use of fuel nor a gigantic apparatus is required, if the apparatus is properly arranged and understandingly handled. The trouble has not been from the inability to produce heat, but from the extraordinary loss of heat, this being occasioned in many cases by the position of the introductory flues, and in other cases by that of the outgoing ventilating ducts. It should be our aim to utilize every particle of heat entering the room before we allow it to escape; it is certainly folly to bring in vast quantities of pure, warmed air at the floor level of a room and send it out with equal rapidity at the

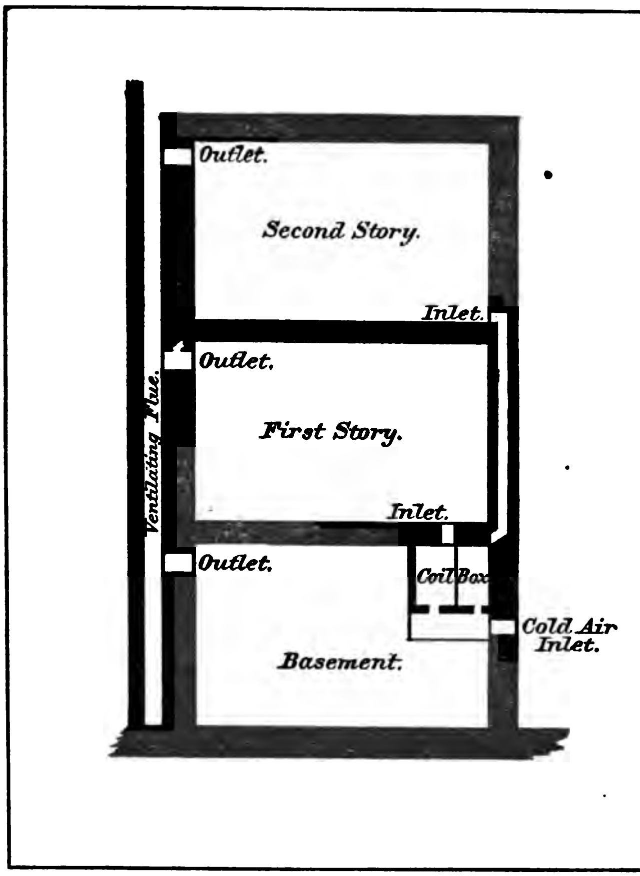


Fig. 7.

ceiling level, without having traversed the room, outside of an almost direct line drawn from the incoming to the outgoing register; yet in many cases our registers are so arranged that it is impossible to get any different results.

I have before said that there is a general unanimity of opinion among experts as to the feasibility of indirect heating, but in regard to the placing of the heating surfaces in the cellar and the position of the incoming and outgoing registers there is a wide diversity of opinion.

I shall endeavor briefly to describe some of the principal methods in common use, and the objections that I have to them, before describing the system adopted in the Bridgeport school building.

First, the placing of the coil boxes in the basement, on the outer walls under the rooms to be heated (Fig. 8), and the introduction of the warmed air at the floor and its removal at the ceiling level upon the opposite side of the room.

The objections that I have to this system are:

1. That in a building like the Bridgeport school there would have to be placed in the basement at least six separate coil-boxes for the generation of heat, arranged one under each room; that by placing these boxes in the basement rooms the rooms are rendered entirely unfit for school purposes, and their utility for playroom is greatly crippled.

2. That by placing these boxes far away from the center of the building, where the boilers are presumably located, a large amount of additional piping becomes necessary throughout the basement.

3. The boxes being placed on the outer walls of the building, there is danger of the pipes freezing; constant watching and attention is required to prevent this and to insure their proper working.

4. That the introduction ducts or flues running up the outer exposed walls of the building lose a great deal of heat by their proximity to the cold; that this loss of heat cannot be wholly obviated even by the most expensive construction; that a large addition to the actually necessary heating surface is required to overcome this loss of heat, caused by the exposed position of the flues.

Lastly, that the air entering upon the outer wall at the floor, and being removed on the inner wall at the ceiling-level, does not benefit the occupants of the room as it should. The action of the air as it enters is rapidly upward to the ceiling, where it stratifies, then along its surface to the outlet, as indicated in Fig. 8. The entering air is warm and light, and naturally rises and flows across the top of the room to the nearest outlet. The foul air of the room, being heavy with impurities, remains at the bottom, becoming constantly more contaminated. There is no doubt a certain amount of radiation or mixing going on, but the great bulk of the pure warmed air

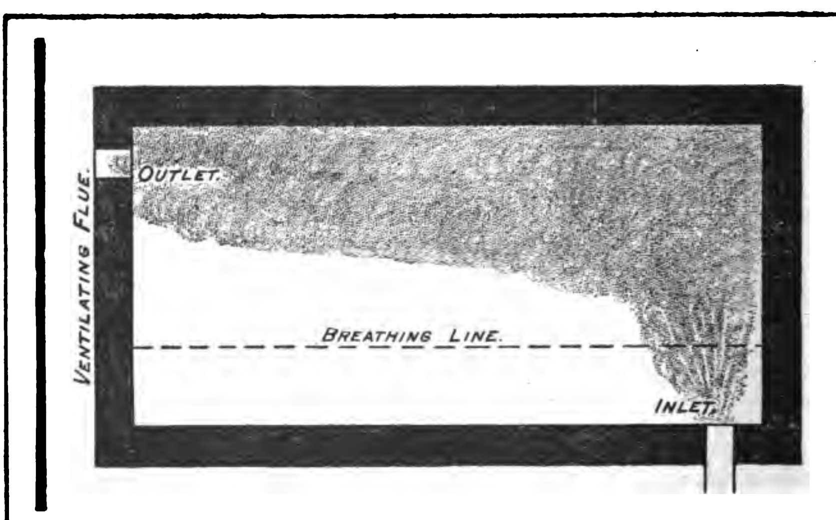


FIG. 8.

entering the room takes the short cut across it and up the ventilating duct, as shown in Fig. 8. This action of the warm air occasions, as may be readily seen, an enormous loss of heat without accomplishing the very results aimed at, the utilization of every particle of heat before it is allowed to escape, and the thorough mixing of the pure incoming air with the air already in the room. If any one doubts the correctness of the action of air as herein described, let him fill the incoming flue with smoke that can be readily seen, and watch its course as it enters, flows upward and outward, and see where the great mass of it goes. The dotted lines on these sketches indicate the breathing point of a person sitting.

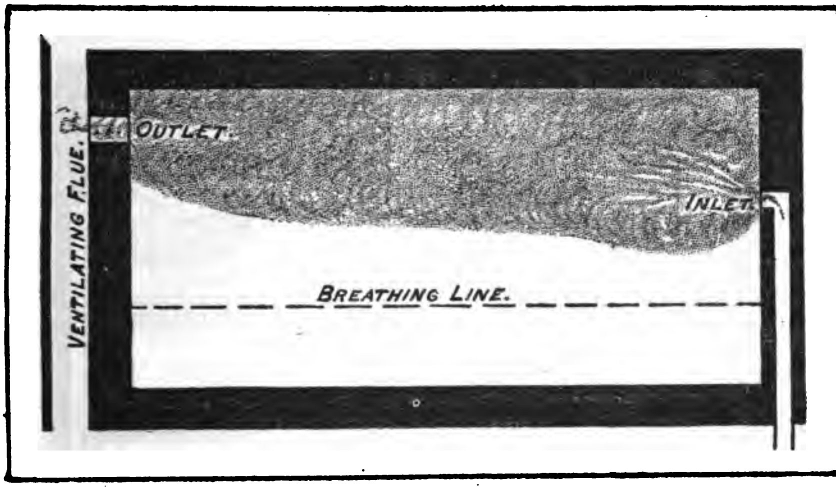


FIG. 9.

It may be well to explain that in the experiments that I have made the outlets have been at least twice as large as the inlets, and that there has always been heat in the outgoing flues to produce a strong up-current, as I believe this to be the only

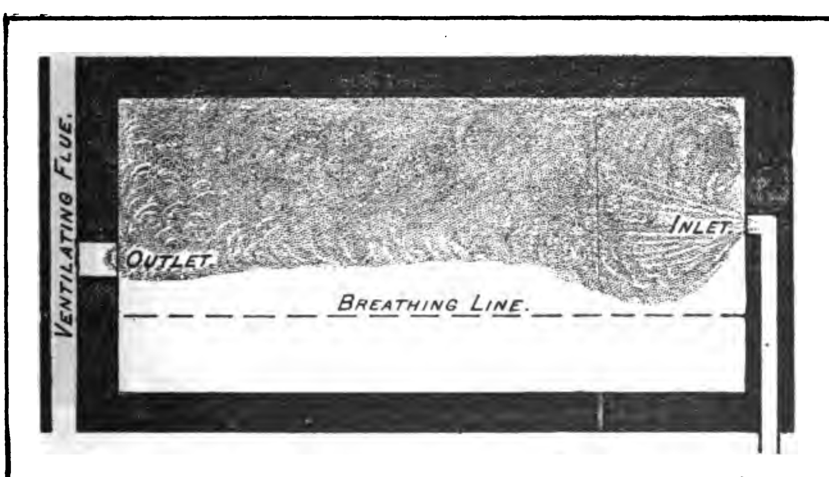


FIG. 10.

sure way to produce a constant outward flow of air. In Fig. 9 the outgoing flue is in the same position, but the incoming flue has been raised about two-thirds of the way towards the ceiling. In Fig. 10 the flues have been placed on about the same level, but with no better results. In Fig. 11 the outgoing flue has been placed at the floor with the results shown in the sketch. In Fig. 12 both flues are at the floor-level with better results than have yet been obtained, but still far from satisfactory. I have thus tried to show the general action of incoming and outgoing currents of air by the placing of the introduction flues on the outer walls and the outlets on the inner.

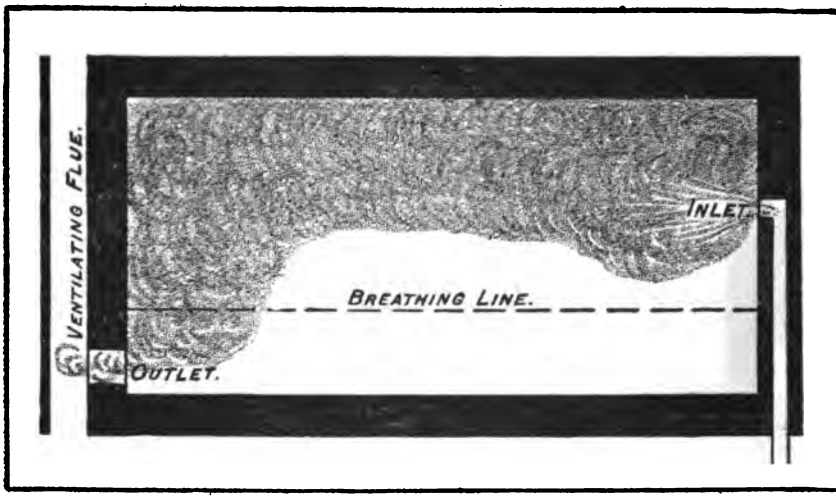


FIG. 11.

The second method in general use is the placing of the coil-boxes upon the inner wall and the removal of the foul air at the opposite or outer side of the rooms. I consider the placing of the coil-boxes on the inner wall a great improvement on

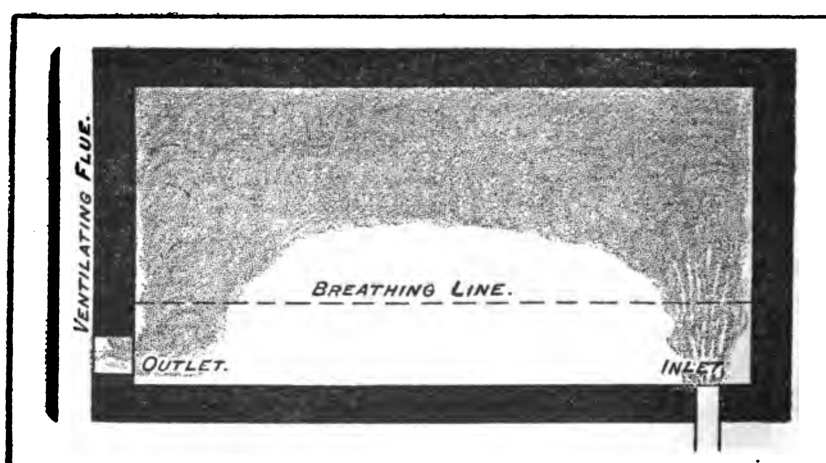


FIG. 12.

the other method, as by this plan they are centralized, extensive piping is saved, and the danger of freezing obviated. The placing of the exhaust flues on the opposite side of the room I believe to be open to the same objections that I have described in the first method. The action of the hot air, from the points where it is introduced toward the various outlets, is the same as in the sketches already shown, and will be readily understood by the reader.

In the Bridgeport school the coil boxes for the heating of the various rooms have all been placed in the main ventilating shafts in the center of the building, and the air conveyed from them through these shafts to the rooms by means of metal tubes. The air enters the inner corner of the room about 8 feet from the floor, the corner being clipped (see plans) so as to form a flat surface for the register opening; underneath the register the space is utilized for a closet for the use of the teacher. The outgoing flue has been placed directly under the platform, which is located in the same corner as the introduction flue. This platform measures 6 by 12 feet, and is supplied with casters, so that it can be moved at any time it is necessary to clean under it. Its entire lower edge is kept about 4 inches from the floor to give a full circulation of air under it at all points. The action of the incoming air is rapidly upward and outward, stratifying as it goes towards the cooler outer walls, thence flowing down their surfaces to the floor and back across the floor to the outgoing register on the inner corner of the room. By this method all the air entering is made to traverse with a circular motion (see Fig. 13) the entire room before it reaches the

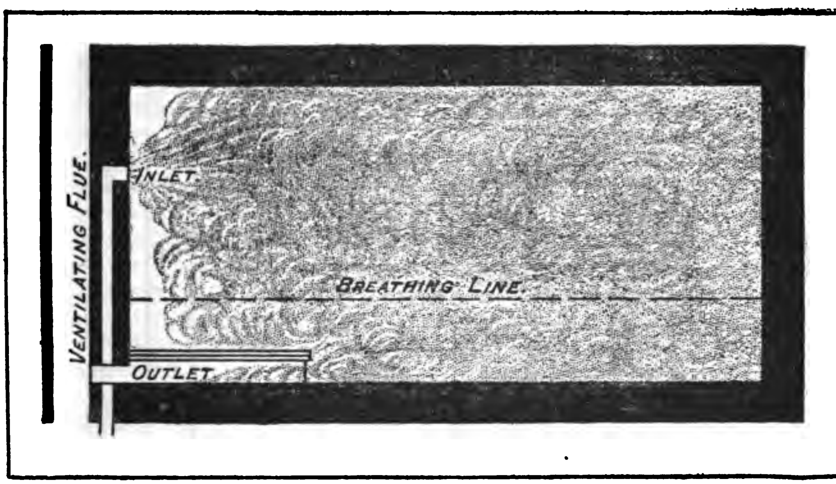


FIG. 13.

exhaust shaft, and there is a constant movement and mixing of the air in all parts of the room continually going on. All the heat entering is utilized, and I believe that if the supply and exhaust flues are properly balanced as to size that there can be a very small loss of heat.

The inlets are all intended to be large, and the flow of air through them moderate and steady. The air is not intended to be heated to a very high temperature; the large quantity introduced is expected to keep the thermometer at about 68° at the breathing level. The schoolrooms contain on an average about 13,000 feet of air, or 260 cubic feet per pupil. It is proposed to supply each pupil with 30 cubic feet of air each minute, or 1,800 cubic feet per hour. Allowing 50 pupils to each room this will necessitate the introduction of 90,000 cubic feet of air into the room each hour, and will change the air of the room 6.92 times within the hour, or once in about 8 minutes. These calculations are based on a difference of 30 degrees in the temperature. In the exhaust flues there are placed coils to produce a strong up-current at all times; heat is also obtained from radiation from the introduction and boiler flues, which run through the foul-air shafts.

Trouble has always been found in regulating the supply of warmed air obtained by the indirect system, owing to the inability to control the heating surfaces. The usual way of constructing the apparatus has been to place in the coil boxes sufficient steam pipe to heat the room in the coldest weather. The pure, cold air passing over the pipes becomes heated to the desired temperature, and is then carried to the rooms. This answers very well during the coldest weather, but as the weather moderates and less heat is required, the only way to regulate it has been to close the registers. This not only lowers the temperature of the room, but shuts off the supply of pure air entering. This fault has been remedied in the Bridgeport schoolhouse as follows: The heating surface (steam pipes) for each room is inclosed in separate

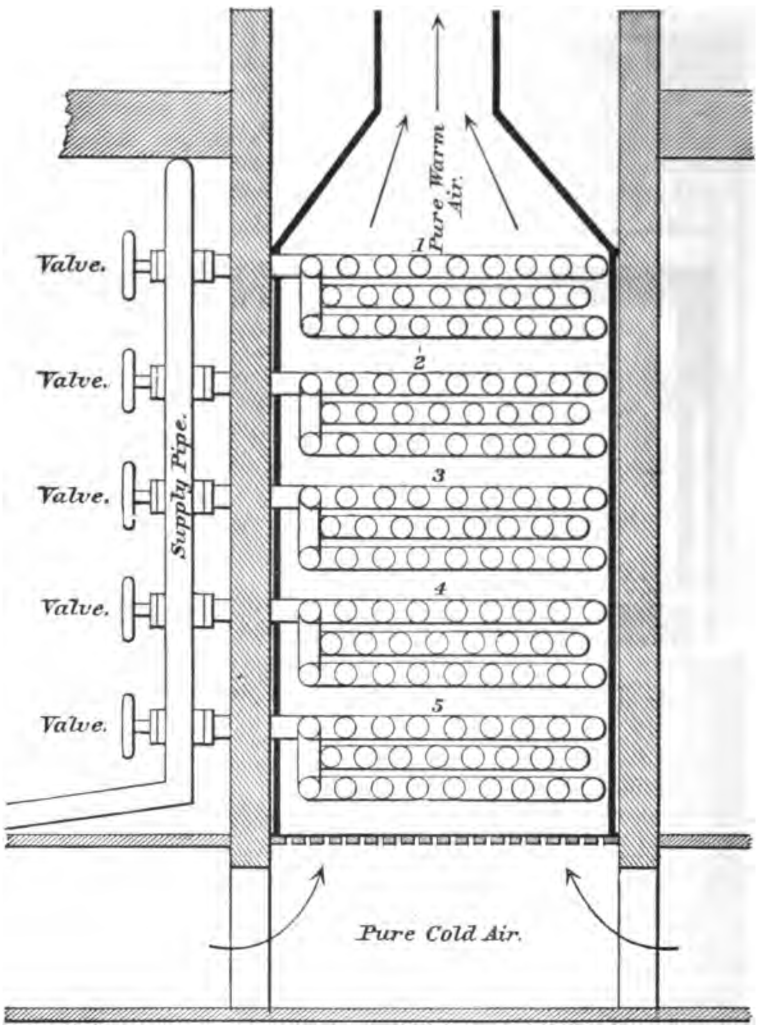


FIG. 14.

cases or jackets (see Fig. 14) of metal, and are then subdivided into five sections, so arranged that any number of sections or the whole may be used at pleasure; that is to say, that any one, two, or three parts may be used at discretion. In extreme cold weather the whole five sections are in use; in moderate weather two or three, and when a small amount of heat is required, only one. By this plan the supply of pure air remains always the same, but the degree to which it is heated is changed by the opening or closing of a steam valve. (See Figure 14.)

The arrangement of all the heating and ventilating apparatus in the center of the building renders it convenient and easy to manage, economical in its construction and effective in working. The advantage is also obtained of having all speaking tubes, call bells, and water pipes run through the ventilating shafts, where they are always accessible, as each shaft is provided with an iron ladder. This system has not only been introduced into each room, but into the halls as well. There are placed, moreover, in the halls foot warmers that are indicated on the plans. These warmers are simply steam pipes incased in tin boxes arranged between the floor joists; the pipes are packed in sand to temper the heat, and are covered at the floor level with checkered iron plates set flush with the floor. The tin cases referred to are water-tight, and have a drip pipe running down to the boiler room, so that in case of a leak no damage may be done to the building.

The boiler room floor is sunk some 6 feet below the level of the ground floor to insure a drip of all return pipes from the coils. The cold-air inlets are on four sides of the building, the openings being about 8 feet from the ground. These inlets are connected so that, whichever way the wind may be, a supply of pure cold air is always assured.

I have thus far spoken only of winter heating and ventilating; for summer ventilation I believe that there are no better inlets for the air than the windows. There are many devices that may be arranged in them that are simple and effective. It is not necessary to describe them here. The outlets, however, need a brief description. It is intended not only to use the outlet under the platform, but by a simple device the incoming register for warm air in winter is made to connect with the main outlet in summer, so that two outlets are provided during the warmer months. The upgoing current in the ventilating shafts is maintained in summer, as well as in winter, by heat; there being placed at the bottom of each shaft a stove, which is to be used constantly when the boilers are not in use, insuring an equally strong up-current in summer as in winter.

I would say, in conclusion, that many interesting experiments have been made and important facts established. These experiments have principally been made with a model of about one-sixth the capacity of the schoolrooms. They have always resulted most satisfactorily, and have proved the correctness of the principles herein advanced against the objections commonly raised that heat brought into the room on the inner walls will not sufficiently warm the outer walls. I would say that in every test yet made the registration of carefully graded thermometers has been from 1° to 2° warmer near the outer wall than near the inner, showing conclusively that the flow of heated air is rapidly towards cool surfaces, and that if its volume is sufficient it will counteract the radiation from the outer walls and render the temperature of the air in their immediate vicinity comfortable. Many other interesting facts have been established, and much useful data obtained, but I have neither the time nor the space here to describe them. I have purposely omitted in this paper all figures not actually necessary, aiming to make it a simple statement of my views, fortified by the results of actual experiments. If any should desire more minute details than are here given, by communicating with the writer he will willingly furnish all the information required, or should any be interested enough to come to this city, he will be pleased to go through with them some of the experiments here mentioned.

The building has been described throughout as it was designed to be built by the architect; some modifications have been found necessary, however, during the progress of the work.

APPENDIX III.

[A. P. Marble, *Worcester, Mass.*]

Since the preceding pages were prepared for the press several new plans for heating and ventilation have been introduced in this city, both in new houses and in old ones, with excellent results. The following description of these houses is taken from the Report of the Worcester, Mass., Schools for 1889. The only uncertainty as to the relative merits of these several systems is the item of cost in fuel consumption; but that will be determined later, and the results will be published. From the report for 1890, the description of the Salisbury Street house, and the instructions to janitors are also inserted.

THE QUINSIGAMOND HOUSE.*

This is a building of four rooms, two on each floor. The exterior is of hard-burned sand-struck bricks, with red mortar and granite trimmings. The facade is sparingly ornamented, but very effective in its simplicity. The basement is half above the ground; and the entrances under porches are raised only one or two steps. All the stairs are under cover and always free from ice. The basements are paved with asphaltum, with whitewashed walls, light, high, and airy. From these on opposite sides there are entrances into the closets—on one side for the boys and on the other for the girls; and from each closet is a door leading to the yard. Great care has been given to the lighting, the heating, the ventilation, and the sanitary arrangements of this house. The windows are massed on two sides of each room. They extend upward to the ceiling, and the sills are about four feet from the floor. They are provided with light colored holland curtains rolling from the bottom; and the sash are hung upon metallic cords. The blackboards are plates of native slate 3 by 4 feet each, extending around the walls in all the vacant spaces. The finish is of brown ash; the ceiling of corrugated iron; the walls of adamant plaster; and the floors of birch.

The heating apparatus consists of two large hot-air furnaces for the schoolrooms, and another for the halls and dressingrooms. The supply of fresh air is ample. It is received, on either side, into two rooms in the corners of the basement, each about 6 by 8 feet and having windows opening on adjacent sides of the house. A large conduit of galvanized iron conducts the air from the top of each of these rooms to a box leading to the bottom of the furnace. Passing into the bottom of the air chamber of the furnace, the air is warmed and it rises through a vertical brick flue some 2½ by 2½ feet in horizontal section, and is delivered into each schoolroom through an opening at least 2½ by 3 feet placed in the wall six or eight feet from the floor. By means of a damper, connected with this flue and controlled in the schoolroom, the hot-air flue may be partly closed and an opening made into the cold-air chamber; and in this way the temperature is regulated without shutting off the supply of fresh air. From each room the air is exhausted through a similar flue leading to the basement. The opening into this flue is in the wall near the floor; both these openings

* See Figs. 53–57.

and those for the ingress of air are protected by wire screens with a mesh of about 1¼ inches, but there is no means of closing them. Unlike the ordinary register, the wire screen obstructs the free passage of air but very little. This flow of air is uninterrupted. The ventilation is continuous. These ventilating flues are connected at the bottom with a large shaft extending through the roof. The upward current in this shaft is produced partly by the heat of the smoke-flue which adjoins it, and partly by a small stove or furnace at the bottom of the shaft. This stove is to be heated always in weather when the furnaces are not in use, and at other times if necessary to secure the draft from the schoolrooms. During school hours, the air is warmed, passed into the schoolroom, where it circulates thoroughly to every part, and out through the ventilators and the shaft, at the rate of at least 30 cubic feet per scholar a minute. By an ingenious, patented, and perhaps unnecessarily complex, contrivance, there is a box through a part of which the cold air is passed into the furnace and through another part of which the vitiated air also passes from the ventilating flues into the shaft; and in this box a large damper is so arranged that by a single motion or half-turn of a crank, the cold air is shut off from the box, and at the same time the air from the schoolroom is shut off from the shaft and turned into the furnace. Thus, at night and while the school is not in session, the air from the room may be circulated through the furnace to be warmed, and back again to the room. The hall furnace opens through registers in the floor in both the halls and the dressing rooms—this for more conveniently warming the feet; and the air from the halls supplies the furnace. Floor-registers are always bad, however, because of the dust from dirty feet. They are less objectionable in halls than in schoolrooms.

The closets are in an extension of the basement beyond the building, on the back side. The vaults are of brick, fire-proof, and so constructed that they may be closed, all at once, by an iron cover at the top; and they are connected by a brick flue, at the surface of the basement, with the smoke flue. At the end of each is a grate in which a fire may be built occasionally, with the tops closed; and the contents are consumed. The pavements of these closets are concrete or slate. The urinals are made of slate slabs set against the wall, slate partitions between the several compartments, a gutter at the bottom leading to the vault, and an opening for ventilation downward, through which the air passes into the vault and up the smoke flue. Lavatories of the ordinary house pattern are provided for the teachers in dressing-rooms on each floor, between the schoolrooms, and adjoining the heating flues. This house is one of the most complete, if not the most complete, in all its appointments, as it is the newest, of any in the city. Its working has been satisfactory, and in accordance with the theory, the past winter. But this winter has been unusually mild. There is no reason to think that it will not be equally satisfactory in the coldest weather.

The cost of this four-room house has been $23,878.55, including $3,800 for the land.

EXTENSIVE REPAIRS.

Material alterations have been made at the Lamartine Street, the Ash Street, and the Belmont Street houses, by which the entire system of heating, ventilation, and closets has been changed; and in each the method employed is different from the other.

At Lamartine street the improvements have been made upon substantially the same principles of heating and ventilation as at the new house described above. The air is heated by four furnaces with a very large area of heating surface; it passes into the schoolrooms through vertical brick flues, in which a damper, operated in the schoolroom by the teacher, regulates the proportion of warm and cold air and thus secures the right temperature. The openings are protected by wire screens, and they can not be closed. The ventilating flues have openings at the floor, and extend downward to the basement, beneath which they are connected with the bottom of a ventilating shaft in which the air is rarified by a furnace to create the draft. The cold air in this house is taken directly to the chamber of the furnace from the outside, instead of from a room in the basement; and in each of these flues there is an automatic damper, a patented device, it is understood, by which too great pressure of air into the furnace is avoided when the wind blows. If the air is forced in too rapidly the flue is partly closed, or wholly closed for the moment, in case of a sudden gust.

The sanitary appliances in this house differ from those at Quinsigamond in this respect; that instead of a fire for burning the contents of the vault, there is a flow of water into the vault, regulated by a ball-cock; and at intervals the contents are discharged into the sewer. The urinals have a trough made of a slab of varying width; and they are ventilated at the bottom. They have no partitions to separate the sections, and they are inferior to those last described. The ventilation of the vaults is through an underground channel into the smoke-flue, like the Quinsigamond house. There appears to be no provision for rotating the air from the rooms through the furnace, to be heated at night, as in the last-named school. A damper in the ventilating shaft, to be closed at night, prevents the motion of the air.

The halls and corridors are heated by the surplus warm air direct from the furnaces, conducted in galvanized iron pipes of large size. The cost of repairs upon this house of twelve rooms, as per auditor's report, has been $8,375.72.

The Ash Street house has been heated by indirect steam with a Sturtevant blower, run by a 10-horse power engine, to force the air through the radiating coil. The air passes into the several rooms through vertical brick flues extending from the basement upward between the schoolrooms; and the openings into the rooms are at a height of 6 or 8 feet from the floor, as in the two last-named houses. The connection from the radiating chamber to these flues is made by galvanized iron conduits; and these conduits have two flues each, one for cold air and one for warm, with a damper controlled by the janitor * in the basement, to regulate the proportion of warm and cold air to be discharged into the room for regulating the temperature. Ventilating flues of brick, built in connection with the hot air flues, opening into the room near the floor, and extending upward and out at the roof, provide means for the exit of air; these flues chiefly depend for their draft upon the pressure of air from the fan, or blower, into the room. Sheet-iron pipes deliver the fresh warm air into each of the dressing rooms. The air is taken from the outside into the blower through a screened window, about three feet wide by five or six feet high. New water-closets have been erected in a separate building in the yard, connected with the schoolhouse, on the girls' side, by a covered and inclosed walk. The building is provided with common earthen-ware hopper closets, flushed from a single tank, all at once, by the janitor in the basement. The urinals are of slate, with slate partitions dividing the sections, and flushed at intervals by the janitor by means of a perforated pipe extending along near the top. This building is warmed by steam coils connected with the boiler. So far as appears, the ventilation is through the windows, the doors, and the monitor-top. The cost of repairing this six-room house has been $4,628.20.

At Belmont street. This large house of 18 rooms was formerly heated by direct steam. In the old part, of 12 rooms, there were no means of ventilation except the doors and windows; and in the addition of 6 rooms the ventilating flues, though 2 from each room were built for exhausting the vitiated air near the floor, were inadequate for that rapid movement of air which is required by late sanitary science. In the heating of this house the direct piping was allowed to remain for use in extreme weather, if it should be found necessary. An additional boiler was set up, and indirect radiating coils were located in brick chambers at convenient points, from which vertical brick flues of large section extend to the several rooms. The fresh air is supplied to these chambers as it is supplied to the furnaces in the Lamartine Street house; and there is the same contrivance for regulating the temperature, by

* It is always preferable for the damper to be controlled by the teacher in the schoolroom.

letting on more or less of the cold air without obstructing the ventilation. This is done by the teacher in each room. Ventilation is secured by means of a circular fan, 7 feet in diameter, placed to revolve horizontally at the foot of a brick shaft. Each room is connected with this shaft through the floor, or near the floor, by means of brick flues or galvanized iron pipes extending to the basement, and communicating with the shaft through a spacious brick passage in the basement. The fan is run by a separate boiler and a 6-horse power engine.

The water closets are located in a separate building in the yard adjoining the schoolhouse and connected with both the basement and the yard. The closets are built above long vaults filled with water, as in the Lamartine Street house. These vaults were at first connected with the ventilating shaft; and so long as the fan was in motion they were well ventilated; but when the fan stopped at the close of school there was nothing to prevent the foul odors from the closets from passing into the schoolrooms. They are now ventilated through another flue heated by a separate stove. The urinals are similar to those at Lamartine street, described above. These closets are heated by direct steam. The cost of these repairs has been $12,257.36.

REMARKS UPON THE VARIOUS METHODS OF HEATING AND VENTILATING.

Though these four houses have been in use one winter, it is too early to judge of their relative merits. With the exception of a slight break in the engine at Ash street, which interrupted the school a day or two, and the ventilation of the closets at Belmont street, which has now been made right, they have all worked well. In each case the tests repeatedly applied have shown an air supply equal to 20 or 30 cubic feet of air per minute per child, which is ample; and in all cases the air in the schoolrooms is quite pure and free from all disagreeable odors.

In order to apply tests to all the newly ventilated schoolhouses under all conditions and for a series of months, the committee on schoolhouses have purchased four or five anemometers or air-meters and placed them in the hands of the principals of the schools, with directions for their uniform use, and for similar records of the results.

It will be observed that the principles applied in the heating and ventilation, and to some extent in the sanitary appliances, at the Quinsigamond and the Lamartine Street houses are identical. In the practical application there are variations. Both these houses are built, in these respects, substantially upon the methods introduced the year before at Dix street, and before that at Ledge street and at Adams square. This plan is known as the Smead system. Its working has been entirely satisfactory in all the houses where it is in use; and so far, none of the methods outlined above have shown any superiority to it. Whether either of them will prove superior can be determined only by experience, and by comparison of the cost of fuel. Whether the furnaces at Quinsigamond which are smaller, or the larger ones at Lamartine street, which have never been used anywhere else, will prove more effective than the Smead furnace, in raising a large volume of air to a moderate temperature; and which of the three will prove the most economical of fuel and the easiest to manage, can be known only by trial, with equally careful and efficient janitors. Whichever proves to be the best should be introduced into the new houses to be built hereafter.

The costly experiments with four methods of heating and ventilating schoolhouses, have placed the city in a position to know what is best; and they have attracted the attention of committees from all parts of the country. It is not likely that five or six different plans, none of them without merit, can be seen in any other one place.

There has been a difference of opinion as to whether a sufficiently rapid change of air in a schoolroom, to supply thirty cubic feet of air per minute to each of forty or fifty pupils, can be secured without some mechanical means. This has been done without machinery at Dix street, Adams square and Ledge street, and the past year at Quinsigamond and at Lamartine street. For very large buildings of irregular construction, and where the basements cannot be used for furnaces with direct vertical flues, indirect steam heat is undoubtedly the best; and a fan is very useful to move the air. But for ordinary schoolhouses, if the radiating surface is large so as never to be overheated, the warm air furnace is more prompt, more direct, and more economical of fuel. Unlike a business block, a schoolhouse is in use only five or six hours a day. During this time the air within should be changed about once in fifteen minutes, and the temperature should be kept steadily at 68° or 70°. For the rest of the twenty-four hours the temperature may be much lower. Under these conditions the heat can be generated quicker and fuel and heat more easily saved when not needed, in a furnace than with a steam boiler. And ventilation can be secured by a heated flue as well as by a fan. The heated flue has this advantage that it will draw when the janitor is not present; while the fan has to stop if the engineer is away, or at the close of school; and there are no conditions under which a flue will not draw if heated. The fan is not always positive in its operation. If all the rooms are closed in a calm day, and if the ducts are of equal length and capacity, and the registers of the same size, a fan will deliver an equal quanity of air to each of several rooms in a given time; but if one of the rooms is opened, or if it is located on the leeward side of the house in a gale, or if its register is larger, then this room will receive from the fan a greater quantity of air than the other rooms. The same is true of an exhaust fan. The fan then depends upon favorable or uniform conditions for uniformity of action, just as much as the heated flue does. It is more expensive, more liable to disorder, requires more care and skill, and does not work alone. It should not be used when the simpler means will do the work as well.

The Salisbury Street house * was completed and occupied for the first time in September, 1890. It contains ten rooms, all spacious and well lighted. The ceilings are of iron. The corridors are broad—almost too roomy; and the house has an elaborate system of heating by steam and ventilation by means of a fan driven by steam power. In this house the system of exhaust ventilation has been introduced. From each room a flue extends to the exhaust-room from which the fan forces the air, thus withdrawing it from the room. With this system there is a practical difficulty: If a door is left open, or if there are cracks around the windows or elsewhere, the cold outer air is urged into the schoolroom. More air is withdrawn by the fan than enters through the heating-stacks. It has now been practically shown that it is much better to force the warm air into the room if a fan is used, as seems advisable in large houses heated by steam. In this case the surplus air which does not find an exit through the ventilating flues, passes outward through the doors when open, and through the crevices around the windows. The quantity of air received into the room through the heating apparatus would be in excess of that which passes outward through the ventilators, this excess finding an exit elsewhere.

DIRECTIONS FOR JANITORS OF SCHOOL-HOUSES, WORCESTER, MASS.

(1) To sweep the entries, stairways, and schoolrooms, and brush out the chalk trays twice each week; and to sweep the entries and stairways daily, when necessary.

(2) To dust the furniture as often as the rooms are swept, and the windows, blinds, walls, and ceilings as frequently as may be necessary to keep them in good order.

(3) To wash the floors, doors, stairs, balusters, seats, desks, and other wood-finish, and to clean carpets during the summer vacations; to wash the windows twice each year—once in the month of April and once the last week in August.

(4) To build fires whenever they are needed, and in season to have the room suitably warmed at the time for opening the schools. Where the buildings are heated by steam the janitor is not to leave the building during the school session without notification and consent of the principal of the school; to give attention to the fire during the day, and to visit the schoolrooms as often as necessary to see that they are properly warmed and not overheated (68 to 70 degrees being the proper temperature)—these visits to be at least once in each school session, and at such hours as may be agreed upon, unless excused by the principal of the school.

(5.) In buildings heated by furnaces and provided with a system of ventilation, janitors are to remain in or about the building, and are not to leave during the

* See Figs. 61, 62.

school session (as per paragraph 4); and under ordinary circumstances the cold-air boxes must be kept wide open for the admission of outside air; in case of very high winds it may be necessary to partly close the slides, but this is to be regarded as exceptional, and must not be practiced habitually.

(6.) When the buildings have no special ventilating apparatus the furnaces are not to be left while the drafts are open; and in buildings of more than four rooms, the janitors are to remain during the school sessions.

(7.) They are to see that the receptacles for water are kept full.

(8.) Where stoves are used, fuel sufficient for the day must be carried to the several rooms. Where steam-heating apparatus is used it shall be kept clean and in good order. Boilers shall all be blown off as often as necessary, and the tubes cleaned once each week. The safety valves should be tried every day, and all other valves kept properly packed. Ashes shall be drawn from under the boilers each day. Janitors of buildings heated by steam will be held responsible for the safety of the pipes from freezing. In extremely cold weather they must take unusual precaution, either by remaining during the night or until satisfied of the safety of the apparatus.

(9.) Janitors must keep themselves informed in regard to the condition of the heating apparatus and give immediate notice of any possible danger arising therefrom.

(10.) It is not required that fires shall be kept up on holidays or during vacations, except enough to protect the apparatus.

(11.) Hot water only to be used in thawing steam or water pipes.

(12.) Janitors shall remove the snow and make paths in the yards leading to the several entrances, and to the outbuildings, and shall pile the snow in a place most convenient for its removal, if necessary; and shall sprinkle sand or ashes upon the walks when in a slippery condition.

(13.) To use the fuel economically; to screen the ashes, and to burn the screenings on the fires.

(14.) To shut any windows that may be left open at the close of the school session, and to keep the windows, outside doors (including those of the outbuilding), and the gates locked except during school hours.

(15.) To take every precaution to avoid accidents from fire.

(16.) Janitors shall maintain a general supervision of the estates during vacation. When workmen are employed on the premises, or when fuel is received, they are to see that none of the property is misused or taken away.

(17.) No person not connected with the schools shall be allowed on the premises without permission from the superintendent of public buildings, or the principal of the school; and smoking in or about the buildings is prohibited.

(18.) To notify the superintendent of public buildings whenever repairs are needed upon the buildings in their care: but janitors are expected to make good small defects around their schoolhouses when such can be done in less time and to greater advantage than by giving notice to the superintendent.

(19.) To do such other work as properly belongs to the office.

(20.) Whenever a vacation occurs of a week or more, janitors shall see that all movable property, such as maps, globes, charts, etc., is securely locked up.

(21.) Janitors, in the performance of their duties, are under the direction of the principals of the schools, and of the superintendent of public buildings, under the direction of the joint standing committee on public buildings.

(22.) Substitutes for janitors must be approved by the superintendent of public buildings; and only in cases of emergency will the employment of an unauthorized person in the place of a janitor be allowed by the superintendent.

(23.) Principals are requested to report monthly to the superintendent of schools upon the conduct of their janitors, and he will notify the suberintendent of public buildings of any neglect or inefficiency.

Approved by the School Committee.

WORCESTER, *November*, 4, 1890.

APPENDIX IV.

PLANS AND SPECIFICATIONS OF SCHOOLHOUSES.

[Extract from a circular issued in 1881 by State Superintendent William C. Whitford, of Wisconsin.]

* * * The ninth design is furnished by Henry C. Koch & Co., architects, of Milwaukee. It is for a one-story, elegant school building, containing three school-

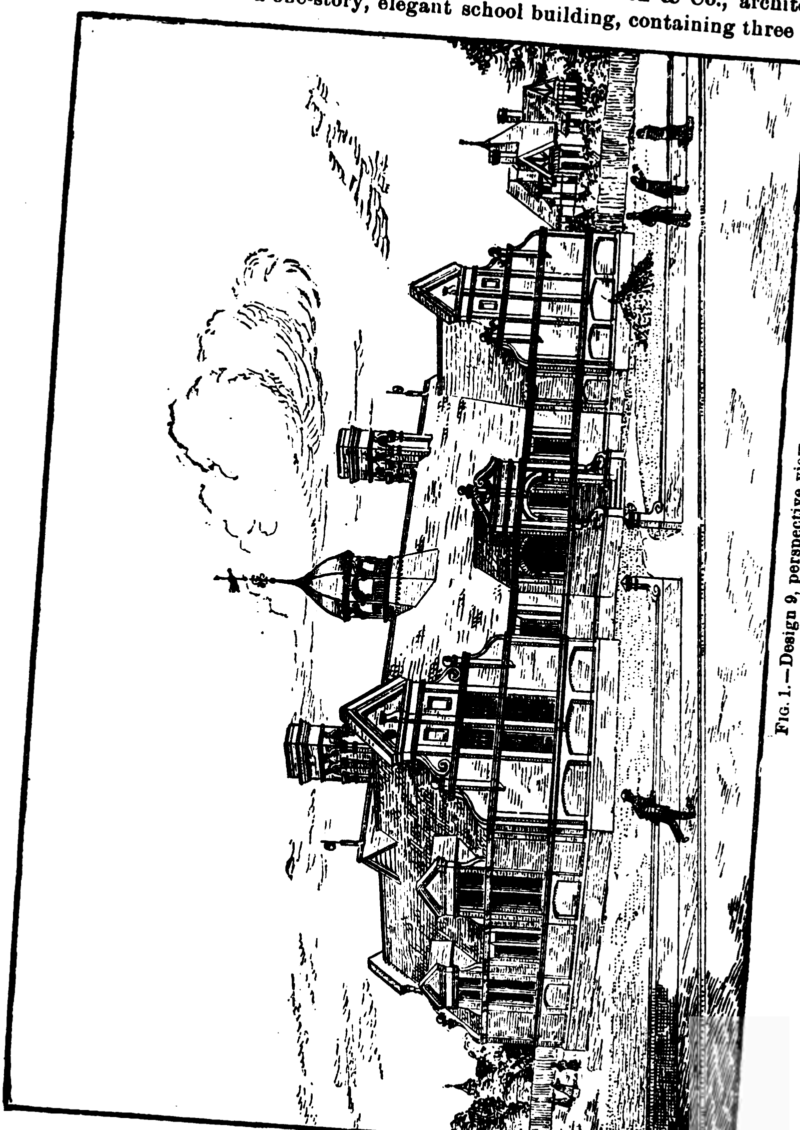


FIG. 1.—Design 9, perspective view.

rooms and a teacher's room, which are connected together by a long corridor in front. Separate wardrobes for girls and boys lead from this corridor into the schoolrooms, and are used for the entrance and exit of the pupils. The schoolrooms are indicated on the plan by the rows of desks. The room shown without desks is for the principal of the school, and can be used for the recitation of classes when necessary.

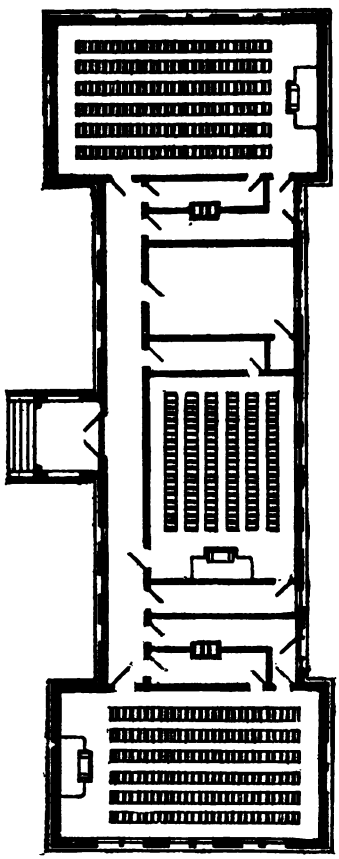


FIG. 2.—Design 9, floor plan.

The central part of the building is 140 by 46 feet, and will accommodate 228 pupils in the three rooms. This design requires that the building be of brick, with a stone basement up to the line of the top of the water table. The belts and pilasters are of brick, and the copings on gables of stone or terra cotta. This roof may be slated or shingled.

The site for the building and the ground immediately surrounding it should be well drained, and drain tile should be laid outside the footing stone on all sides of the building, with a slight inclination to the point of the outlet. The foundation walls should be laid with cement mortar up to the line of water table.

The bottom of the cellar should be covered with small stone spalls or clean coarse gravel, to a depth of at least 4 inches, and then grouted with liquid cement. When the grouting is set, the floor should be finished with a coat of Portland cement at least 1 inch thick.

The plastering on the walls should be sand-finish, floated off straight and true, and rounded into the frames on the jambs of the windows. No wood casings are used. The plastering should be continued down to the floor, full to the face of the grounds for wainscoting. The ceilings should be finished white, with the usual hard coat.

The floors should be of maple or other hard wood, dressed and matched, not over 2¼ inches wide on the face, and smoothed off after being laid.

All the corridors and schoolrooms should be wainscoted from the floor to the height of the window stools. The wardrobes should be wainscoted 6 feet high from the floor, and all finished with a neat capping. Back of each teacher's platform is the blackboard, and the top of the wainscoting below the blackboard is finished with a shelf for chalk.

The teacher's platform should be located as on the plan, so that the rays of light will be over the left shoulders of the pupils as they face the teacher.

The building can be heated by means of two furnaces, using the center flue in each stack for the smoke flue. The stacks are shown on plan, located between the wardrobes at each end of the building. The two remaining flues in each stack are for ventilation. The warm-air flues are carried up in the walls between the rooms, which they may enter through registers above, at, or near, the floor. A sufficient number of registers will be inserted in the floor, equally distributed, in each room, and a foul-air duct connected with each of these and the main foul-air duct. This last duct is connected with one of the vent flues in the stack, and extends along the

NOTE.—This house is not compact. The cost is too great for the accommodation. The admission of warm air is not on correct principles, as outlined above; and there is no provision for water-closets. A. P. M.

ceiling of the basement to a point necessary to receive all the branch ducts from the registers in the floors.

The capacity of the main duct should be fully equal to the combined capacity of all the branch ducts which it receives. All the foul-air ducts should be made as nearly air-tight as possible.

The important consideration in this branch of the work is to provide inlets for fresh air and outlets for foul air, both of sufficient capacity to insure a complete change of the air in the room in the shortest time possible without producing a perceptible draft. The capacity of the foul-air ducts should always exceed that of the fresh-air ducts.

The eleventh design, furnished by H. C. Koch & Co., architects, of Milwaukee, is of a building to be erected in a small city or populous village. It is two stories high and contains four schoolrooms and two teachers' or recitation rooms. The latter are each 16 by 18 feet in the floor area. The upper story is a repetition of the lower

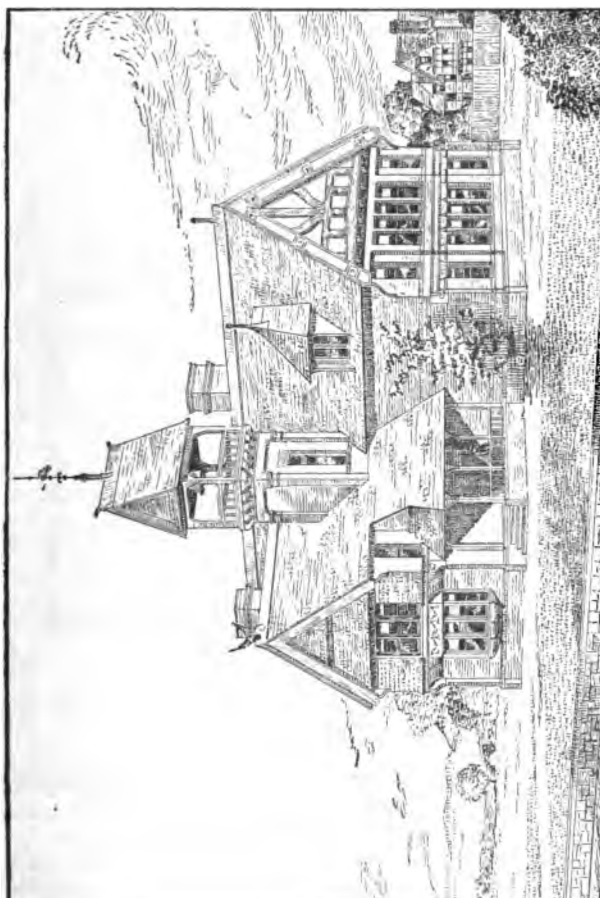


FIG. 3.—Design 11, perspective view.

one, as indicated on the plan, and each should be 14 feet in height. The main portion of the building is 67 by 45 feet at the base, and the wing, not including the porch, is 26¾ by 24¾ feet.

Both brick and wood are required in the construction. The front gable above the first story is frame, as are also the end gables from the line of the eaves, and the remainder of the outside walls, as well as the inside ones, are built of brick. The frame portions of the gables project over the walls below and are finished with shingles. The end gables are in imitation of timber work. The style of the building, while unusual, is plain and very attractive. The cost of erection is by no means greatly increased by the new features. The method of shingling portions of the outside walls, employed in this design as well as in some others in this circular, is a return to the plans used in this country over a hundred years ago. Such a covering is found to be warmer than clapboarding and to wear much longer. Besides it gives a picturesque effect to the building.

See description under ninth design for the construction of the foundation and cellar, and for the finish of the inside throughout.

Each schoolroom will accommodate 60 pupils, seated at single desks. The separate wardrobes for the sexes and connected with each room furnish all needed facilities for depositing the clothing. Through them the girls and boys enter and leave the room at different doors. The extra room on each floor for the teachers or for the recitation of small classes will prove very desirable additions.

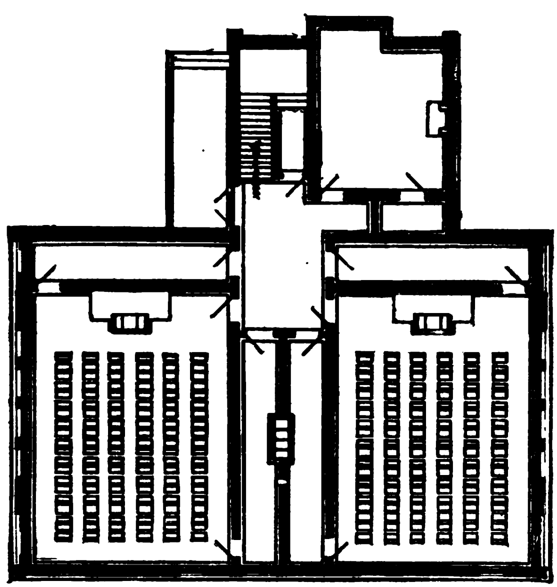


FIG. 4.—Design 11, first and second floors.

The grouping of the principal windows at the side of the study rooms is in conformity to the established principles for the wholesome admission of light. In one-half of the building the light is received on the right side of the pupils. This is more advisable than to require them to sit facing the windows at the rear end of the room, or even the blank wall at the side, with a very large share of the light streaming over their backs upon their books or papers on the desks.

The twelfth design was prepared by Messrs. Edbrooke & Burnham, architects, of Chicago. It presents the appearance of a solid, enduring, symmetrical, and imposing structure. Its external embellishments are few and simple, and therefore adapted to its general style. It would be an ornament to any village or city.

The outside walls of the basement are built of stone, 18 inches in thickness, and its partition walls of brick, 8 inches in thickness. The exterior walls of the first and second stories are brick, 12 inches in thickness, and the partition walls are wood, with studding varying in size for the places it occupies. The height of the basement in the clear between joists is 7 feet 8 inches; of the first story, 13 feet 3 inches; and of the second story, 14 feet 3 inches. The sectional area of the house, measured at the base of the first story, is 49 feet 6 inches by 52 feet.

The building furnishes the usual conveniences for corridors, pupils' wardrobes, teachers' or recitation rooms, and apartments for study. Two quite spacious rooms are set apart in the basement as play rooms for girls and boys. These can be used in wet or stormy weather, or in places where no sufficient playgrounds can be provided in the school yard. Each schoolroom will accommodate 35 pupils at single desks, or very comfortably 42 pupils at double desks. Each of the former number would have 19.7 square feet of floor surface, and of the latter almost 16.5 square

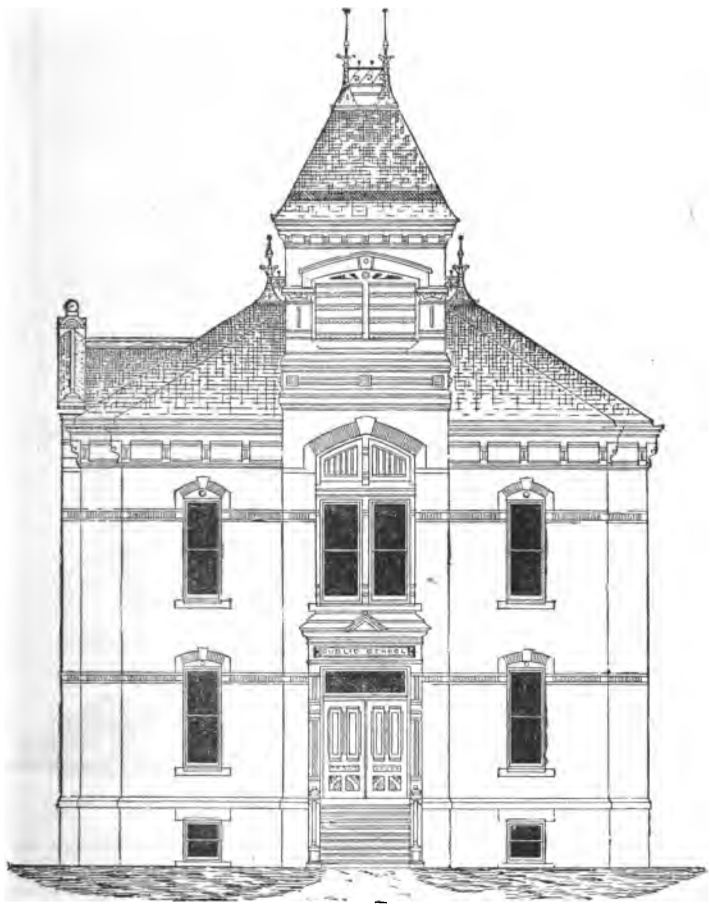


FIG. 5.—Design 12, front elevation.

feet. If small children should occupy the rooms on the first floor, one row of seven single desks could be added to each room with the double desks, and in it 49 pupils would then be seated and each have slightly over 14 square feet of floor space.

The crowning feature of this schoolhouse consists in the arrangements for the ventilation of all its parts. A more complete and perfect application of the Ruttan system to a school building has never before been devised. In this design it has been effected under the immediate direction of Isaac D. Smead, the able representative of this system. The accompanying plans and sections exhibit the details of the arrangements for the heating and ventilation of the building.

Immediately underneath the platform of the front steps, as seen on the longitudinal section, is the fresh-air chamber, communicating with the outdoors through windows covered with heavy wire screens. From this chamber a fresh-air duct leads under the large sized furnace, as shown in the basement of the longitudinal section, which is made on the line A B. The heated air enters through short flues into the corridor and directors' or recitation room on the first floor, and warms also the stairway and the corridor on the second floor. The wardrobes on both floors could be partially warmed by opening the doors from the corridors. The recitation room on the second floor is supplied with air from the furnace through a small flue in the partition below, which is built of brick. The four schoolrooms receive this air through a central flue, in which a damper regulates the supply for the first floor.

FIG. 6.—Design 12, left side elevation.

The foul air is exhausted from the recitation and school rooms through the perforated iron bases under the windows; passes under the floors between the joists; descends through the partitions between the studding, as indicated in both the longitudinal section and the transverse one for the foul-air gathering room, and is drawn through the privy vaults into the ventilating shaft, which is 3½ by 4 feet on the inside. Here a powerful draft is produced from the air forced into it by the action of the furnace and by the heat supplied by the upright smoke pipe in the shaft.

The construction of the separate privies for girls and boys is shown in the basement plan and in the smaller transverse section. The excrementitious discharges fall from the seats into the vaults beneath, which are each 4½ feet deep and 17 inches wide. The contents from the urinals in the boys' privy are emptied through a pipe at the foot of the ventilating shaft. The exhausted air, as it passes over these dis-

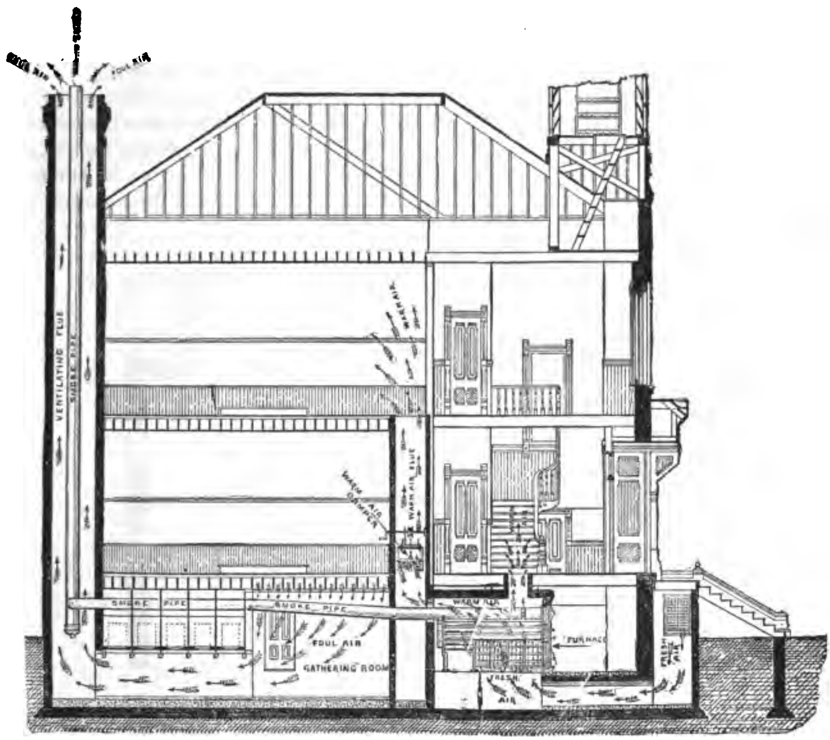


FIG. 7.—Design 12, longitudinal section.

FIG. 8.—Design 12, transverse sections, privy vaults, and foul-air room.

charges into this shaft, rapidly carries away the watery vapor and the gases produced by their decomposition, and thoroughly dries them. Only about one-sixth of these fæces by weight remains in the vaults after being subjected to this process; and this residuum is, easily and with no offensive odor, shoveled occasionally into baskets and carried out of the building. The practicability of this arrangement can not be questioned. It has been tested with complete success in private houses and institutions of learning and the testimony is that no impure air, even in the summer season, rises from the vaults and penetrates the apartments of the houses. It is at that time also withdrawn through the ventilating shafts.

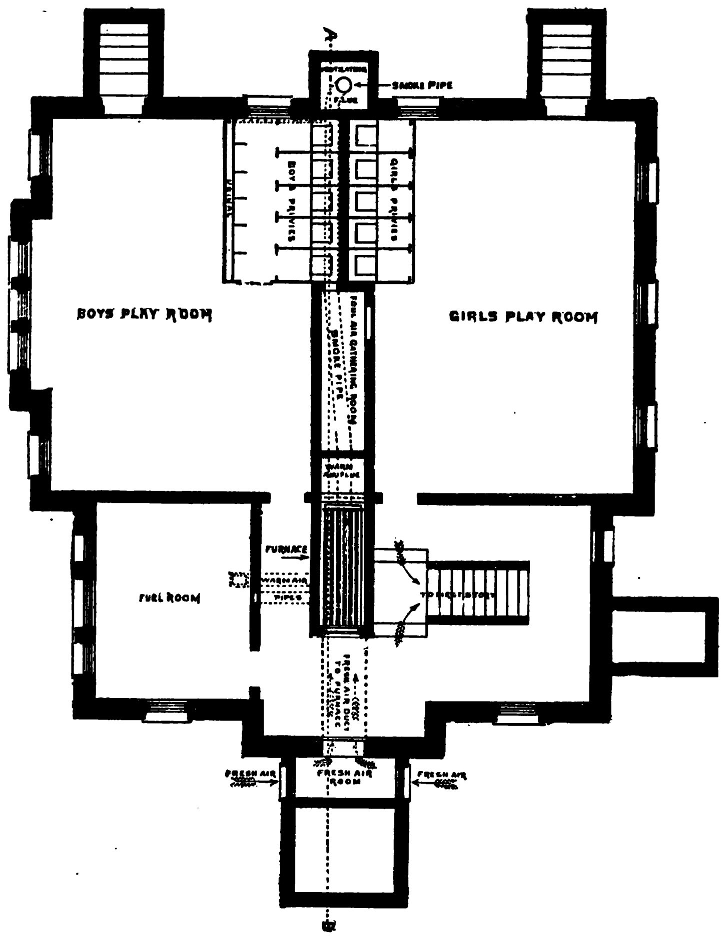


FIG. 9.—Design 12, basement plan.

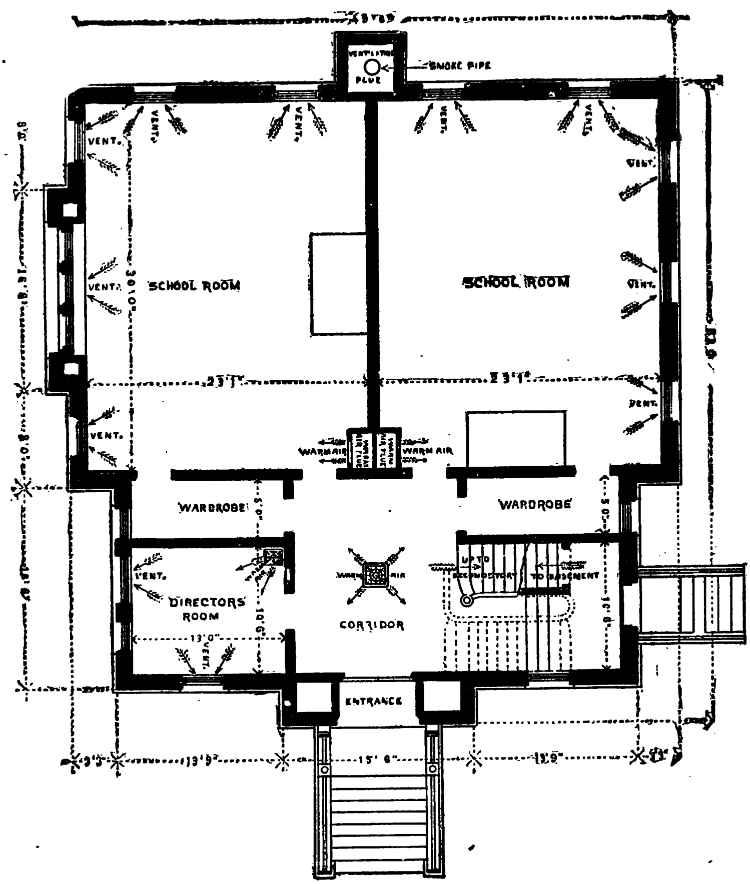


FIG. 10.—Design 12, first floor plan.

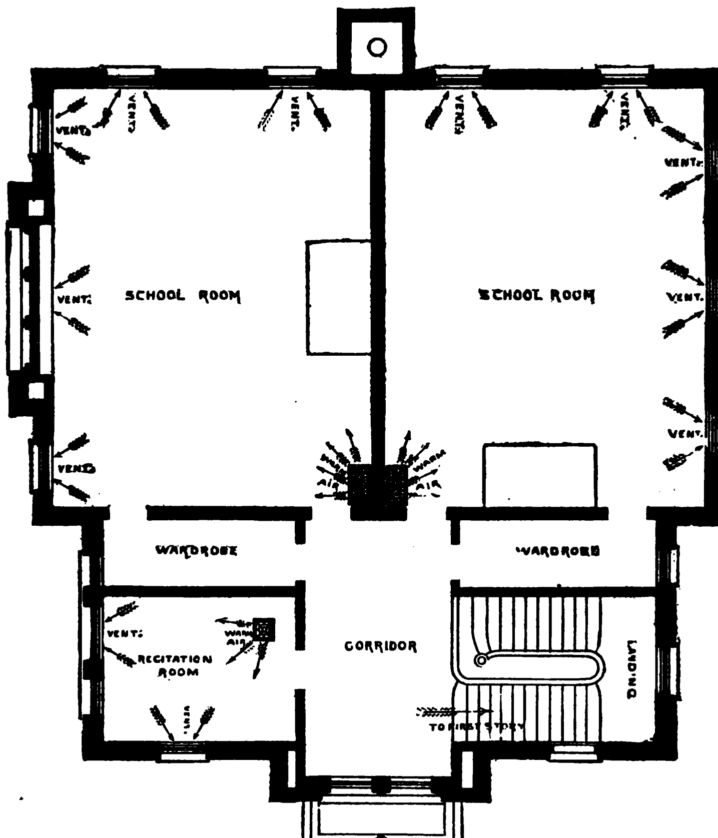


FIG. 11.—Design 12, second floor plan.

Five-room schoolhouse.—The only design with this number of schoolrooms is found below. It was donated by Messrs. Edbrooke and Burnham, architects, of Chicago, Illinois. It was first prepared by them for the school district in the village of River Falls, Wisconsin, where the erection of the building was completed in 1880, at a cost of $12,000. This does not include any of the heating apparatus or the furniture.

It is truly a magnificent structure, striking in appearance, commodious in all its arrangements, and corresponding in very many points to the best recognized principles of schoolhouse architecture. It stands on a slight eminence facing the south. It has separate entrances on the sides for girls and boys, and accommodates in its schoolrooms 275 pupils, in the three grades of a public school.

FIG. 12.—Design 13, perspective view.

Should a fire ever occur in the house affecting either stairway, the school can readily escape from all the rooms through the other stairway. Passage is easily made to the different portions of the house through the corridors and the stairways, and to the outbuildings in the rear by means of doors in the back ends of the entrance halls. The front doors could be set, without injury to the architectural appearance of the house, so far within these halls that the steps for entrance could be placed in them under cover. It will be observed that all the doors by which the pupils enter the building and the rooms on the first and second floors open outwards.

The Ruttan system of heating and ventilating is in operation in this building. An admirable feature of this system is the location of the smoke and ventilating shaft in the center of the house, where its walls are not cooled by exposure to the external air.

The height of the basement story is 8 feet 3 inches in the clear; of the first story, 14 feet 5 inches; and of the second story, 16 feet 4 inches, and 14 feet 3 inches. The height of the tower and other parts of the building are as shown in the perspective and section.

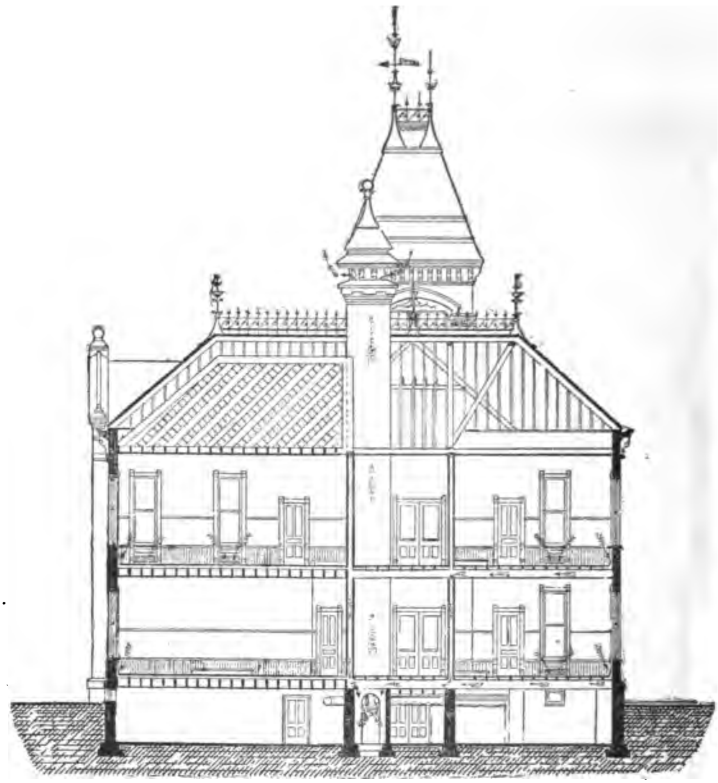


FIG. 13.—Design 13, longitudinal section.

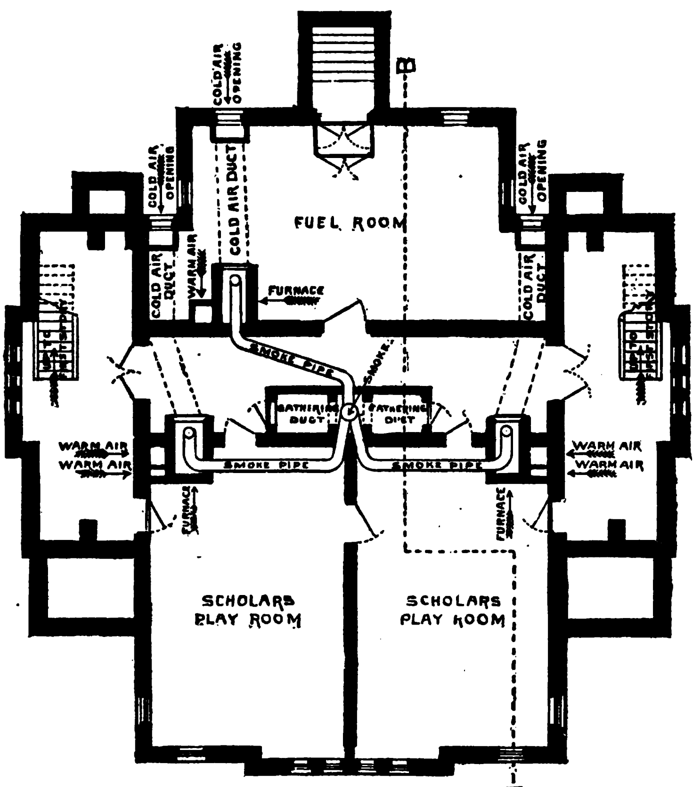


FIG. 14.—Design 13, basement plan.

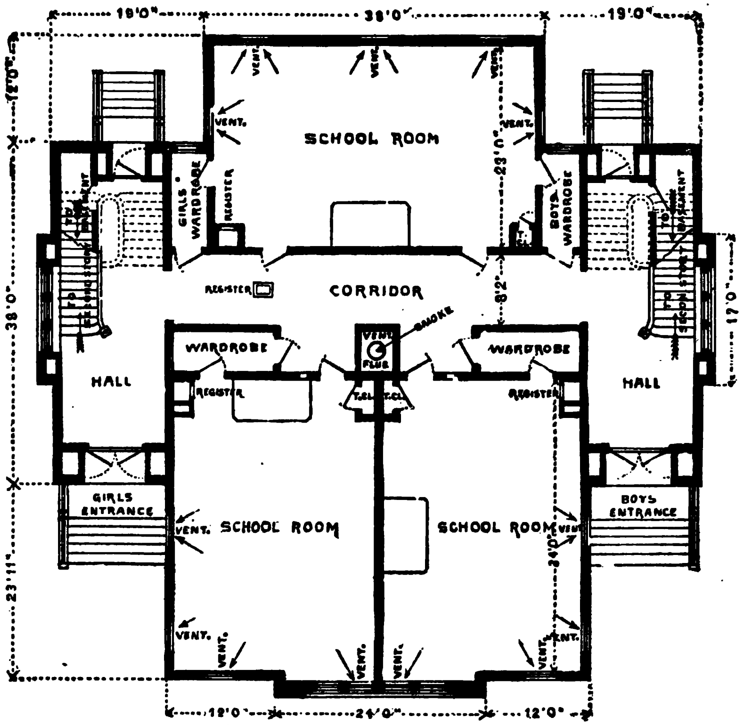


Fig. 15.—Design 13, first-floor plan.

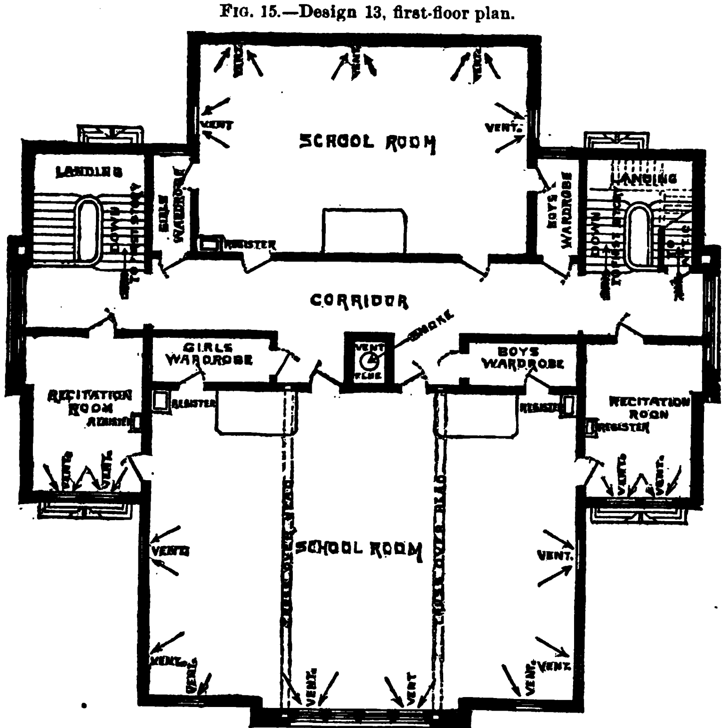


Fig. 16.—Design 13, second-floor plan.

APPENDIX V.

*DESIGNS FOR SCHOOLHOUSES.—REPRODUCTION OF WORK ISSUED JULY, 1888, SHOWING DESIGNS ACCEPTED BY THE DEPARTMENT OF PUBLIC INSTRUCTION OF NEW YORK.**

INTRODUCTORY.

STATE OF NEW YORK, DEPARTMENT OF PUBLIC INSTRUCTION,
SUPERINTENDENT'S OFFICE, *Albany, June* 15, 1888.

Chapter 675 of the laws of 1887 authorized and directed the State superintendent of public instruction to procure architects' plans and specifications for a series of school buildings ranging in cost from $600 to $10,000, together with full detail working plans and directions for the erection of the same. It also directed him to accompany them with blank forms for builders' contracts and with suggestions in relation to the preparation of the grounds and the arrangement of the building with reference to lighting, heating, ventilating, and the health and convenience of teachers and pupils, and then to publish the whole in convenient form for distribution to trustees and others having use therefor.

Acting under this statute and with a desire to carry out its manifest purpose to supply school officers with the most modern and artistic plans or designs for the erection of low-priced schoolhouses, as well as with the latest and fullest information upon the general and important questions relating to the carrying out of the same, the State Superintendent, by circular dated September 20, 1887, invited the architects of the country to present in competition plans and specifications for school buildings of different sizes and cost, and used a portion of the sum appropriated in said act for the purpose of providing prizes for the most meritorious designs.

Designs were invited for any or all of the following-described buildings:

Frame building to cost not to exceed $600, to accommodate from 20 to 40 pupils in one schoolroom.

Frame building to cost not to exceed $1,000, to accommodate 40 to 60 pupils in one schoolroom, or two if a temporary division can be arranged.

Frame building to cost not to exceed $1,500, to accommodate from 60 to 100 pupils in two schoolrooms.

Frame building to cost not to exceed $2,500, to accommodate from 100 to 120 pupils in two schoolrooms.

Frame or brick building to cost not to exceed $5,000, to accommodate from 120 to 175 pupils in three schoolrooms.

Brick building to cost not to exceed $10,000, to accommodate from 175 to 250 pupils in four schoolrooms, and to have an exhibition hall.

Two prizes were offered in each of the above classes: To the designer of the best arranged and most complete building in classes 1, 2, 3, 4, and 5, respectively, the sum of $100, and to the designer of the next best in each of said classes, the sum of $50; to the designer of the best and most complete building in class 6, the sum of $150; and to the designer of the next best, the sum of $75. The right was reserved to make no award in any class where the design presented was not sufficiently meritorious, in the judgment of the committee, for the use indicated.

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* For plans, see page 123 *et seq.*

Ex-State Superintendent William B. Ruggles; Prof. J. W. Kimball, president of the State Teachers' Association; Superintendent Charles E. Gorton, president of the State council of superintendents; Principal E. H. Cook, of the Potsdam Normal School; Dr. George A. Bacon, representing the Associated Academic Principals; Willis R. Hall, school commissioner of the second district of Chenango County, and Mr. Albert W. Fuller, architect, of the city of Albany, accepted my invitation to act as a committee to examine all designs submitted and to award the prizes. The report of the committee is submitted herewith.

It was stipulated that all designs submitted should become the property of the State, with the right to publish meritorious designs which did not receive the highest commendation of the committee, giving designers in all cases proper credit for authorship.

The movement proposed was undertaken in the hope that it would result in more attractive and comfortable low-priced schoolhouses in this State. For reasons which will appear obvious upon reflection, there has heretofore been but little done in this direction. At the popular centers the buildings are generally fair, and when new ones are erected they are ordinarily very creditable. But outside of the large communities many of the buildings are truly wretched, erected without any idea of architectural effect, and entirely regardless of those matters upon which the health and comfort of the pupils mostly depend. Old buildings, in a shameful state of decay, are continued in use year after year. When new ones are erected it is considered unnecessary or too expensive to employ professional help, and so the best results are not secured. We are endeavoring to arouse and educate public sentiment upon the subject. We are telling the people that the health and eyesight and comfort of teachers and pupils are worth caring for. We are striving to impress upon them the fact that neat and wholesome buildings in themselves exert a strong moral and educational influence. It is believed that we can do this most effectively by placing in their hands the most meritorious designs, the latest information, and the best helps. Showing them just how to do a good thing will accomplish more than simply telling them they ought to do it. * * *

A. S. DRAPER,
State Superintendent.

SCHOOLHOUSE GROUNDS.

To the ordinary observer the country schoolhouse presents little that is picturesque or restful to the eye; often more that is suggestive of dilapidation and a general lack of attention to repairs and a proper maintenance of the structure itself. The grounds surrounding the building are entirely neglected, presenting altogether a picture as uninteresting as the country affords.

The house is largely located with reference to the center of population and its accessibility to the children of the district. The topographical features of the site are not especially considered, but a location near the intersection of the country roads or a convenient one on the highway is generally preferred. The structure is without architectural merit, the grounds are worn bare, and the absence of tree and shrub makes still more dreary and uninviting the general aspect of the building and its surroundings.

Is it a wonder that the children go reluctantly to school and run away from the locality as soon as they can; that they are careless as to the condition of their surroundings and of the school property; that they destroy the turf and make bats and shinny-sticks of any isolated fence picket or small tree in the vicinity? They are not allowed to play tops in their sitting rooms at home or marbles on their dining-room tables. Can the children be taught to respect, take an interest in, or care for a lawn, tree, or shrub, if introduced as an embellishment to the immediate surroundings of a country schoolhouse, when such a treatment of a portion of the grounds would seem to conflict with the impetuosity of their movements or their rights as players of shinny, baseball and marbles?

This result has been accomplished in cities where the population is more dense, and occasionally in the country, by affording ample opportunity and space for such games at a point not too remote from the school building and restricting the children to this locality for such sports.

It is evident that it is impossible to maintain a lawn or turf where shinny, marbles, baseball, and similar games are permitted. On the other hand, we should be loath to sacrifice the pleasure and health of our children for a bit of lawn or the pleasing effect of a few shade trees. Can these conflicting elements be harmonized? Can we let the children play and still have some grass and shade and inviting grounds around our country schoolhouses? Where children and grown people as well find neglect and want of care the rule, they are apt to reciprocate in kind, and become careless. One is inclined to be a little more circumspect in his outward behavior, surrounded by objects of value and comfort at home, than on a barn floor. A wholesome restraint is educational and beneficial in its effects. If ample facility is afforded the children for games and they are not permitted the use of that portion of the grounds improved, the teachers could soon interest them and teach them to respect the locality.

If in the spring and fall an arbor day was selected for the planting of such material as might be selected for the purpose, and the children given a holiday to assist in the work, an interest in the condition and growth of the trees would soon be developed that would not be restricted to the schoolhouse grounds, but extend to the wayside and the homes of the children. How can this be satisfactorily accomplished and how are we to go to work to obtain this result? In a general way as follows:

Select a proper site, build a commodious, comfortable, and neat structure, surround it by grounds of sufficient size to offer some opportunity for embellishment, apart from the utilitarian requirements of the children, and afford them ample space for an unlimited indulgence in games away from the immediate surroundings of the schoolhouse. The selection of a site is vital to picturesque effect, and a sufficiency of ground essential to the development of such a scheme. The exposure of the schoolhouse with reference to the sun and the prevailing winter winds is an important factor tending to the comfort of the children, and the topographical features of the site are equally important elements in solving economically the questions of drainage and the treatment of the grounds.

Select a site, therefore, that is convenient to the majority of the children attending school, one somewhat retired and sufficiently removed from the street or highway to afford a sense of seclusion and freedom from noise. The ground should be elevated and removed from unsanitary influences or surroundings. Face the house to get plenty of sun, and locate the site, if possible, with reference to the protection afforded by a natural forest growth on the north and west exposures, and when this can not be secured protect this side by evergreen planting. Give protection from the summer sun by detached grouping of deciduous trees sufficiently near to afford shade. Set apart an ample space for the children's playground at a convenient distance on the east or west side. Make the approaches to the building of ample width to facilitate a rapid depletion of the grounds in front, and treat this exposure simply as a lawn, relieved by detached grouping of trees or shrubbery, as the extent of the lawn surface may determine.

The necessary outbuildings should be properly screened with evergreens. The location, exposure, and topography will determine the plan of treatment, so that an arbitrary ground plan would not be applicable in every case. Suitable evergreens for protective screens or for shutting out objectionable features or views can be generally secured in the country where the white pine, Norway spruce, hemlock, and arbor-vitæ are indigenous to the locality; and deciduous trees, such as maples, oaks, ash, beech, and dogwood, with many desirable native shrubs, can often be found among the second growth on the hillsides, the open borders of woods, or along neglected fence lines. Unless an intelligent supervision, however, is given to the selection and removal of such specimens of native growth, the result of such planting is usually a failure. Nursery-grown stock is cheaper, and the immediate results are more satisfactory.

Generally speaking, both evergreen and deciduous planting meets with better success in the spring than in the fall. Especially is this the case when the holes are dug in the fall, filled with good loamy soil, and this allowed to become mellow before planting the following spring. A better and choicer selection of planting material can, of course, be obtained from the nursery, and where this is resorted to a selection can be obtained differing essentially from the field or native stock in form and color, thus overcoming the objection to a repetition or monotony of planting. Generally, nurserymen of established reputation are willing to select such material as would be desirable when sufficient data are furnished them bearing upon the subjects of climate, exposure, character of soil, and the scope of treatment.

These suggestions, though somewhat vague, and not especially detailed in character, it is hoped will tend to awaken a spirit of reform and improvement, so far as the condition and treatment of suburban and country schoolhouse grounds are concerned.—*Wm. S. Egerton.*

School Outbuildings.

LOCATION.

The schoolhouse should, if possible, be so located that there shall be a yard in the rear, divided by a tight fence 7 feet high extending from the house to the rear line of the school lot. The laws of the State, as well as all rules of propriety and decency, require that every schoolhouse shall have an entirely separate outbuilding for each sex. It is usually far better and safer that they should not be under the schoolhouse roof. In addition to the separating fence each outbuilding should be inclosed by a high tight fence, the gates of which are kept closed when school is not in session.

If possible, let each outbuilding be connected with the schoolhouse by a covered walk with latticed sides as a protection to the children in stormy weather. (*See* Fig. 1.)

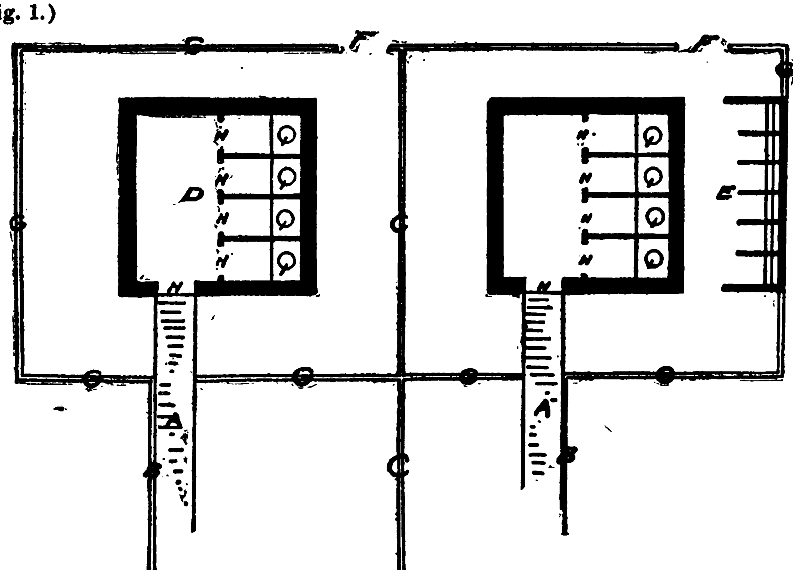

FIG. 1.—*A*, covered walk; *B*, lattice fence; *C*, tight fence 7 feet high; *D*, closets, each in separate compartment; *E*, urinals under cover and separated by partitions; *F*, gates for removal of contents or receptacles; *G*, board fence; *H*, doors; *I*, closet seats.

For plan for disconnected outbuildings and yards, see Fig. 2.

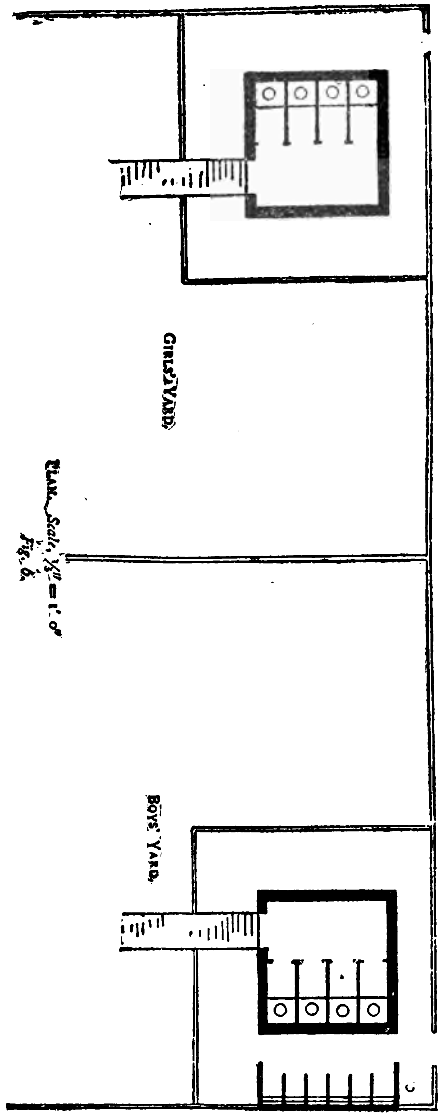

Fig. 2.

RECEPTACLES BENEATH THE BUILDINGS.

Vaults are uncleanly, and the gases which they generate pollute the air, and are not only offensive, but dangerous. Besides, by infiltration through the soil, the contents have, in numerous instances, reached wells, and thus spread fatal diseases. Vaults should never be tolerated. Where connection can be made with a sewer, and a supply of water can be had, the best plan is to lay a 6-inch iron drain-pipe below the reach of frost, beneath the seats of the closet, extending the whole length of the building. Let an upright pipe of 4-inch iron be connected with the above-mentioned main, and extend upward and connect with an enameled iron hopper. Water is brought from the cellar of the schoolhouse by an iron pipe which extends up to the top of the bowl or hopper. Water should be kept running during the time when the closets are liable to be used. This will prevent the adherence of any substance to the surface of the bowls.

The iron leader carrying the water from the roof of the closets should enter the upper end or head of the drain pipe under the seats, that every rain may aid in washing out the sewer pipes. All joints of the drain pipe should be leaded, and a trap set to prevent any odors from coming into the closets from the sewers. This trap should be ventilated, as shown in Fig. 2. The water pipe should be so laid that there shall be a good descent all the way from the top of the bowl to the cellar drain, that when the water is shut off it may run back and out before it freezes.

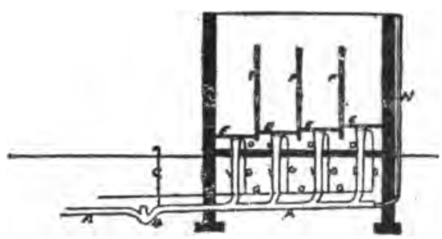

FIG. 3.—Section of closet showing arrangement for drain system. *A*, 6-inch iron drain connecting with sewer; *B*, trap; *C*, vent pipe; *D*, enameled iron flushing hopper; *E*, seats; *F*, partitions; *G*, water supply pipes; *H*, iron leader from roof; *I*, 4-inch iron outlet pipe.

When closets are constructed as above described, they give no trouble, even in the winter. The arrangement of the pipes is also shown in Fig. 2.

EARTH CLOSETS.

When a sewer is not accessible, the best and cheapest receptacle is the earth closet. Construct a plank box 32 inches wide, 18 inches deep, and as long as the building. This may be set upon the surface of the ground, or let into the ground 6 or 8 inches. It should be so placed as to extend only about 2 inches under the riser (front support of the seats in the closet). It will then project about 15 inches back of the building; cover this projection with a slanting door hinged to the back of the building.

Dry earth or ashes should be thrown in daily. Plant several elm or willow trees near the building, to take up the liquids which will, to some extent, pass out of the box into the soil.

During the winter salt should be frequently thrown into the box to prevent the contents from becoming frozen to such an extent as to prevent removal. By raising the lid in the rear the contents can be readily shoveled into a cart or wagon. Gardeners will gladly remove the contents without charge.

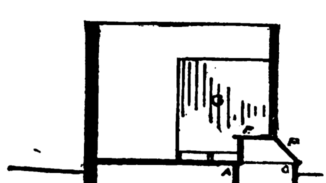

FIG. 4.—Section of earth closet. *A*, *B*, *C*, *D*, box used as receptacle; *E*, seat; *F*, hinged lid, used in removal of contents; *G*, compartment partition.

The above arrangement is much cheaper than a vault, is safe, and is easily managed at small expense. (See Fig. 5.)

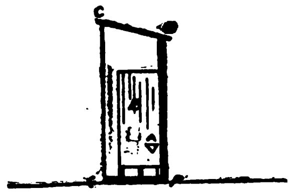

FIG. 5.—Section of urinal shed. *A*, end of urinal; *B*, partition; *C*, *D*, *E*, *F*, urinal shed with compartment partitions.

CLOSET BUILDINGS.

These are best built of brick, though wood is more commonly used. They should always be partitioned into compartments (see Fig. 1), each large enough for only one person. Each of the two buildings, required by law, should have three or more compartments, though in the case of a very small school two compartments may be sufficient. For every schoolroom seating forty or fifty pupils there should be at least two compartments in the closet for each sex. The seats should be large enough for only one person; the compartments or sections should not be more than 2 feet 2 inches wide. Each should have a separate door, which can be closed by the pupils, but can not be fastened on either side. These doors should be locked as soon as school closes at night and opened only a short time before school begins in the morning. The partitions between the compartments should extend from the floor to the roof. (See Fig. 3.)

The distance from the front of the closed door to the seat should be 3 feet. Let the seats be graduated in height, according to the ages of the pupils. For the youngest, seats should be not more than 10 inches high. The inside of the riser, supporting the front of the seat, should be lined with zinc, or it will soon become saturated and very offensive. It is folly to slant the seat or to place any obstruction above it.

URINALS.

One of the most prolific causes of the outrageously filthy condition of boys' outbuildings is the lack of proper urinals. These should always be constructed of some nonabsorbing material, as enameled iron, for which boards lined with zinc are a fair substitute. They must be under shelter, and to secure proper privacy there is here also the same need of partitions as in the closets. There should be more urinals than closet compartments.

In case of closets connected with a sewer, as previously described, the partition of the closets extends back about 30 inches, and the roof is continued back sufficiently to cover them. The urinals are here made of enameled iron, the lowest point of each being at its center; *i. e.*, they are shaped like an elongated hopper. An inch lead pipe leads down from the lowest point and enters the upright drain pipe under each seat. The openings from the bottom of the urinals should be covered by a piece of coarse brass wire cloth, to prevent stoppage by any solid substance thrown therein. In summer it is well to keep on the wire screen several pieces of copperas as a disinfectant. All boards liable to become saturated with the liquids should be covered with zinc. (See Fig. 6.)

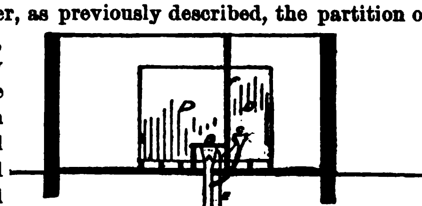

FIG. 6.—Section of closet, showing how urinal may be drained into outlet of bowl. *A*, hopper; *B*, seat; *C*, urinal; *D*, compartment partitions; *E*, water supply pipe; *F*, partitions.

In case of earth closets, let properly covered and partitioned urinals be built in the rear of the closet next to the inclosing fence. A drain should be so arranged as to conduct the liquids into the soil for some considerable distance, there to be appropriated by trees and grass. The joints of the tile should not be cemented. The building should be painted within and without.

While vaults ought never to be allowed to exist, yet they may be rendered more tolerable by pouring in, every week during warm weather, a pail of water containing four pounds of dissolved copperas and an ounce of crude carbolic acid. This solution should be poured into drains quite frequently during warm weather.

The trustees, having put the outbuildings in proper condition, should hold the teacher to a strict accountability for their preservation. The first soiling or pencil marking must be removed immediately, as it is far easier to keep closets scrupulously clean than in a half-cleanly condition.

The law requiring separate closets for each sex,* and that they shall be neat and clean, is explicit, and the penalty for its violation severe. If the closets are properly constructed, are made neat and cleanly, and are inspected daily by a teacher who is determined to succeed in this matter, and who can create a proper sentiment among the pupils, the great disgrace of filthy and obscene outbuildings will speedily disappear from our school grounds.—*H. R. Sanford.*

VENTILATION.

There is no one thing connected with the economies of school life that is worth so much and costs so little as proper ventilation. Many schools are pronounced inferior (and rightly so), and many teachers oftentimes fail in the proper education of such schools, because the physical conditions upon which all mental development is based are wanting. Nothing adds more to the enjoyment of life, nothing is more absolutely necessary for mental work than pure air and an abundance of it. A schoolroom fitted for children to occupy must have two essential provisions. There must be an adequate supply of pure, warm air, and the foul air must be removed in order to give place to the pure air. This must be done in such a manner as to prevent all drafts that will endanger the lives of the children. Without stopping to give reasons for certain necessary arrangements, it is proposed to suggest simple plans:

In building an ordinary single-room district schoolhouse, a brick flue should be constructed, at least 2 by 3 feet in the clear; this flue should contain within it an 8-inch heavy iron pipe, placed in the center and extending fully 2 feet above the top of the brick flue; the brick flue should extend down into the basement, and directly under the floor should be connected by means of pipes with two or more registers placed in opposite parts of the room directly in the floor, being careful not to place them under the seats. These registers should be at least 16 by 20 inches, and after the fire is built in the morning should always be open. When the fire has been burning sufficiently long to warm the iron pipe, there will be an upward current of air in the brick flue, which will at once begin to exhaust the vitiated air of the schoolroom.

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*Chapter 538 of the Laws of 1887, entitled "An act in relation to health and decency in the school districts of this State," is as follows:

"SECTION 1. From and after the first day of September, 1887, the board of education, or the trustee or trustees having supervision over any school district of this State, shall provide suitable and convenient water-closets or privies for each of the schools under their charge, at least two in number, which shall be entirely separated each from the other, and having separate means of access, and the approaches thereto shall be separated by a substantial close fence not less than seven feet in height. It shall be the duty of the officers aforesaid to keep the same in a clean and wholesome condition, and a failure to comply with the provisions of this act on the part of the trustees shall be sufficient grounds for removal from office, and for withholding from the district any share of the public moneys of the State. Any expense incurred by the trustees aforesaid in carrying out the requirements of this act shall be a charge upon the district, when such expense shall have been approved by the school commissioner of the district within which the school district is located; and a tax may be levied therefor without a vote of the district."

To provide fresh air, if an ordinary stove is used, an opening can be made directly under the center of the stove, about 12 by 16 inches, with a pipe fitted to this, running into the basement and connected with the outside; never to be left opening into the cellar. This pipe, or wooden box, if preferred, should contain a damper, which may be closed at night, and by means of which the supply of fresh air may be regulated, depending on the wind and temperature. This pipe under the stove should extend to within 4 inches of the bottom of the stove, and should be fitted with a flange running over the entire bottom of the stove and projecting 2 inches beyond on both sides, with an edge turned up about 3 inches, so as to give an upward direction to the air as it becomes heated by the bottom and sides of the stoves.

When a furnace is used, a much better supply of heated air can always be furnished, but the fresh-air supply should always be connected with the outside, and never be taken from the cellar or schoolroom itself, as the air from either of these places would endanger the health of the occupants.

The principles involved in the foregoing are the same to be used in a building of two, four, six, eight rooms, or of any size whatever. They may be briefly enunciated as follows:

1. Two hundred cubic feet of air should be allowed for each scholar, provided the air is changed continuously.*

2. The foul air should be taken out of the rooms at or near the floor.

3. The ventilating flue should be of sufficient capacity to take out the foul air.

4. The ventilating flues should always be heated to be of any value in exhausting air.

5. The supply of fresh air must be warmed, and the amount of fresh air must be sufficient to compensate for that taken out by the foul-air shaft.

SUGGESTIONS.

1. When furnaces or indirect steam is used in the construction of new buildings, the warm fresh air in the schoolrooms should be admitted above the children's heads. In the cloakroom or hallway there should be one or two registers placed in the floor for the purpose of drying and warming feet and clothes; but unless absolutely necessary, these should never be placed in the floor of the schoolroom, as there is nothing more disagreeable than the odor of drying boots and clothes in a room used for daily school work.

2. If school trustees, parents, and teachers really understood how much more mental work can be done in a schoolroom properly supplied with fresh warm air than in a room where the air has become vitiated and unfit to breathe, a month would not elapse before some adequate provision would be made in this direction.

3. It is estimated by competent authorities who have gathered the statistics, that vitiated air in the houses of our citizens causes 40 per cent. of the deaths annually occurring.

4. Every schoolroom should be provided with a series of the lime-water bottles, showing the per cent. of vitiated air and determining when it is dangerous. A series of such bottles are inexpensive, and at the request of the Association of New York State School Commissioners have been prepared and may be obtained by applying to C. W. Bardeen, of Syracuse.

I hope that these suggestions may prove of value to the teachers and school trustees of our State, and trust that they may be the means of urging upon those in authority the necessity of furnishing our children with that which they need in order to do good work, and which may be had freely at slight expense.—*E. H. Cook.*

*According to the recommendation of the State Board of Health of New York.

LIGHT AND EYESIGHT.

Convincing arguments, supported by statistics, have been advanced by eminent writers, directing attention to the injurious influences of too much school work and insufficiently lighted schoolrooms upon the acuteness of vision, but unfortunately little attention has been given to remedying an evil which has incapacitated thousands of children for the comfortable enjoyment of one of the most important of the senses. Properly lighted schoolrooms promote a healthy influence upon the faculty of visual application. Good light is indispensably necessary for the comfortable exercise of the power of vision, and any architectural interference with the manner of introduction and distribution of the same is injurious to the eye and prejudicial to health. It is during the period of school years that the eyes of children are prone to lose their acuteness, thereby becoming more susceptible to influences tending to a development of refractive disturbances. The golden rule for the guidance of teachers is to refrain from overburdening the eyes with school work requiring long and close application, but the observance of this rule is of little consequence, if, in the architectural design of school buildings, the fact that good light is essential to acute vision and favorable to good health is overlooked. Light is one of the abundant gifts of God to man; its presence is essential to the faculty of seeing; it is an important factor for the preservation of vision, and it is a pity that, by the abuse of its virtues, a single eye should be robbed of its normal acuteness. The wrong done to children by exacting proficiency in a curriculum of high standard, under the injurious influences of too much school work and a faulty arrangement of light-supply, can no longer be ascribed to ignorance on the part of the teacher, or a want of the knowledge of construction on the part of the architect; and if, in the future, the much needed reform of less school work, aided by a proper and well-regulated supply of light, be inaugurated, it will do much to lessen the large percentage of refractive errors acquired during the period of school life. The quantity of light introduced into schoolrooms should be of sufficient strength to fully stimulate the faculty of vision. If necessary, space and symmetry of schoolrooms should be sacrificed to architectural plans best calculated to afford such light that will make the visual act a pleasure and not a burden. Methods adopted for the introduction of light in school buildings should be perfected to a degree admitting of complete control of the quantity required and the regulation of the same. Special attention should be given to the location and size of windows, the quality of glass, and the mounting of the same in a manner that will not interfere with the transmission of light by the reflection of shadows. Low windows should be condemned, and the windows covered by hangings or shades that will admit of controlling the light, so that the supply may be introduced from above and not from below. The appliances by which light is admitted and tempered should, in color, be of neutral tint, so as to protect the eyes from the annoyance of reflecting effect. Light should not be so sparingly admitted as to be insufficient for the purposes required, nor too strong to be trying or dazzling to the eyes.

The source of light-supply in school buildings should admit of being so governed as not to come from opposite directions. Seats and desks should be so arranged that the quantity of light required should come from above and from the left side. Plate glass of equal density, clear and free from flaws and irregularities, is best calculated for the free transmission of light. The custom of introducing windows of tinted or cathedral glass may add to the appearance of school buildings, but possesses the disadvantages of diminishing the intensity of light and altering the equality of its elements. The walls and ceilings of schoolrooms should be tinted in colors, preventing any glaring effect, and, under all circumstances, the effect of light upon the eye should be soft, free from glare, and of sufficient strength to see with clearness and to admit of study with comfort.—*Herman Bendell, M. D.*

BLACKBOARDS.

EXTENT.

Blackboards should extend entirely around every schoolroom. It is better that the top should be 6¼ feet from the floor, to enable the teacher to place work on the blackboard to remain from day to day. For the use of the young children the boards should reach to within about 2 feet from the floor. This will give a vertical width of blackboard surface of about 54 inches.

MATERIAL.

Slate boards have frequently seams, are noisy, and, from the expense, schools fitted with stone boards usually have a very inadequate supply.

Wooden boards are noisy and generally very unsatisfactory.

Neither slated plaster walls nor blackboard plastic materials seem to wear well.

Paper boards have been in use for nearly 20 years, and when properly constructed, are as durable as the walls themselves, and delight all who use them.

HOW TO MAKE PAPER BLACKBOARDS.

When a new building is to be erected, let the walls be plastered in the usual manner, except that the final coat, instead of being composed only of lime-putty and plaster of Paris should contain also sufficient good sharp sand to make a very hard surface, and it must be troweled till *perfectly* smooth.

When the plaster is fully dry, it is ready for the paper. Select manilla paper of medium thickness, not thick, having a good, smooth, calendered surface. Spread the paper cut to the appropriate size on a clean floor, and wet it with cold water, using a clean whitewash brush; apply good cooked flour paste (cold); lay the paper on the wall and smooth it down with a brush, as in ordinary paper-hanging. A soft cloth can be used instead of a brush. Nail a neat molding around the edge.

When dry, apply any *good* slating, and the next day rub the slating with fine sandpaper. Apply two or three coats in the same manner, rubbing each coat as the first. If the slating is of good quality, the boards, though constantly used, will not need to be reslated within 2 or 3 years. It is probably economy to apply three or four coatings of slating at first, as it will prove far more durable. Old cement boards or slated walls, if they are reasonably solid, may be cheaply converted into good boards by first filling smoothly any cracks and holes by a mixture of lime-putty and plaster of Paris, and then applying paper, as described above. Paper will not adhere to thick coats of whitewash. If old walls are loose and shaky they should be replaced by new ones and then papered, as in new walls.

Boards should not be washed, but can be well cleaned with a piece of dry flannel.

If the erasers are made of a material which will hold the dust, and they are dusted every day by striking them against a board out of doors, there will not be very much annoyance from crayon dust.—*H. R. Sanford.*

SCHOOL DESKS.

Double desks cause the spread of vermin and disease, and the contamination of the pure, by close relationship with immoral seat-mates; the amount of genuine study is lessened, and the need of disclipine is increased by children sitting together at the same desk. The best schools have generally adopted single desks, and no double desks ought to be purchased.

In the matter of adaptation to the needs of the schoolroom, comfort and appearance, the best school furniture now leaves little to be desired, and the best will, in the end, be found the cheapest.

Great care should be exercised to adapt the height of seats and desks to the size of the children who are to occupy them.—*H. R. Sanford.*

COMPETITIVE PLANS

FOR

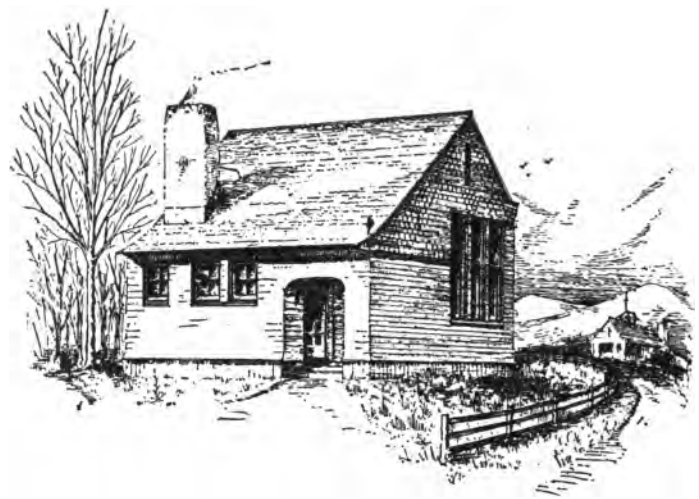
SCHOOLHOUSES.

Nos. 1 to 19, inclusive.

TO ILLUSTRATE APPENDIX V.

PLAN Nº1
PLATE I

CLASS I
$600



PERSPECTIVE

1ST PRIZE: Wm. P. Appleyard & E. A. Bowd. Lansing. Mich.

Fig. 7.

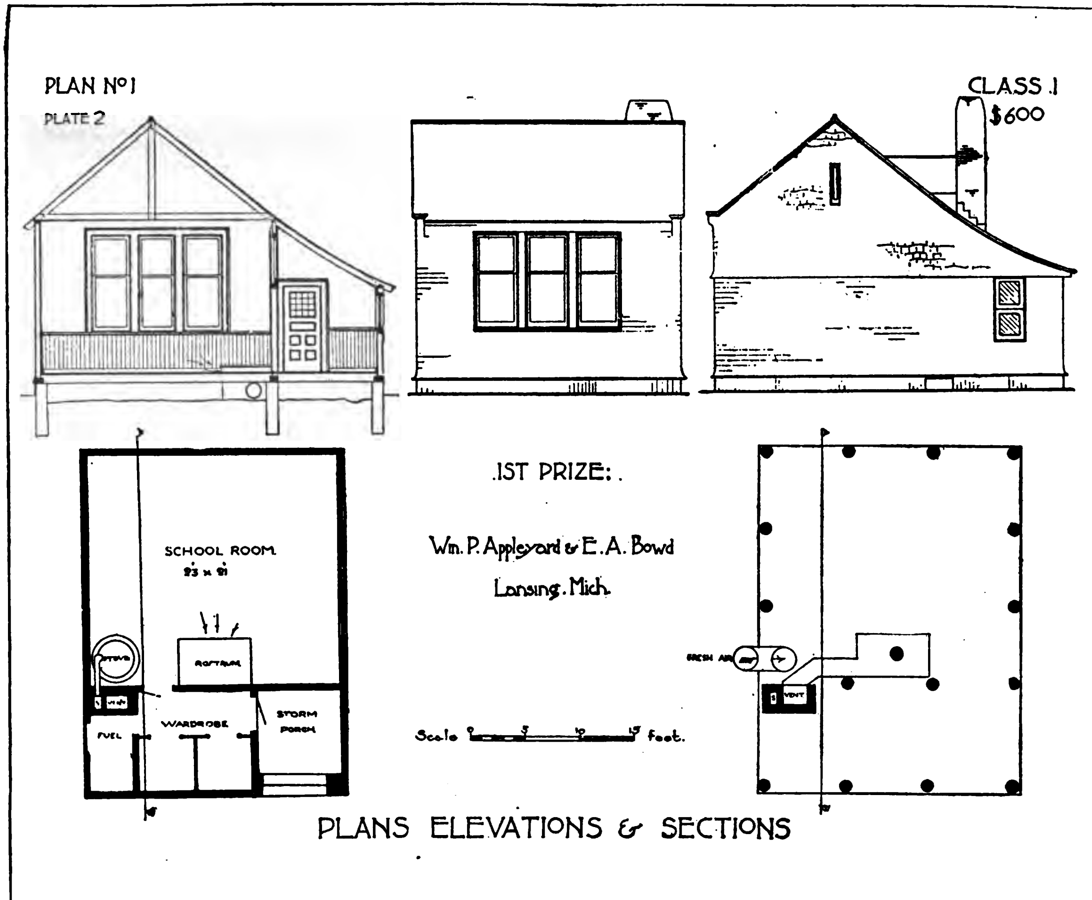

PLAN No 1
PLATE 2
CLASS 1
$600
1ST PRIZE:.
Wm. P. Appleyard & E. A. Bowd
Lansing. Mich.
SCHOOL ROOM
23 x 21
ROSTRUM
STOVE
FUEL
WARDROBE
STORM PORCH
FRESH AIR
VENT
Scale 0 5 10 15 feet.
PLANS ELEVATIONS & SECTIONS

Fig. 8.

PLAN Nº 2.

PLATE I.

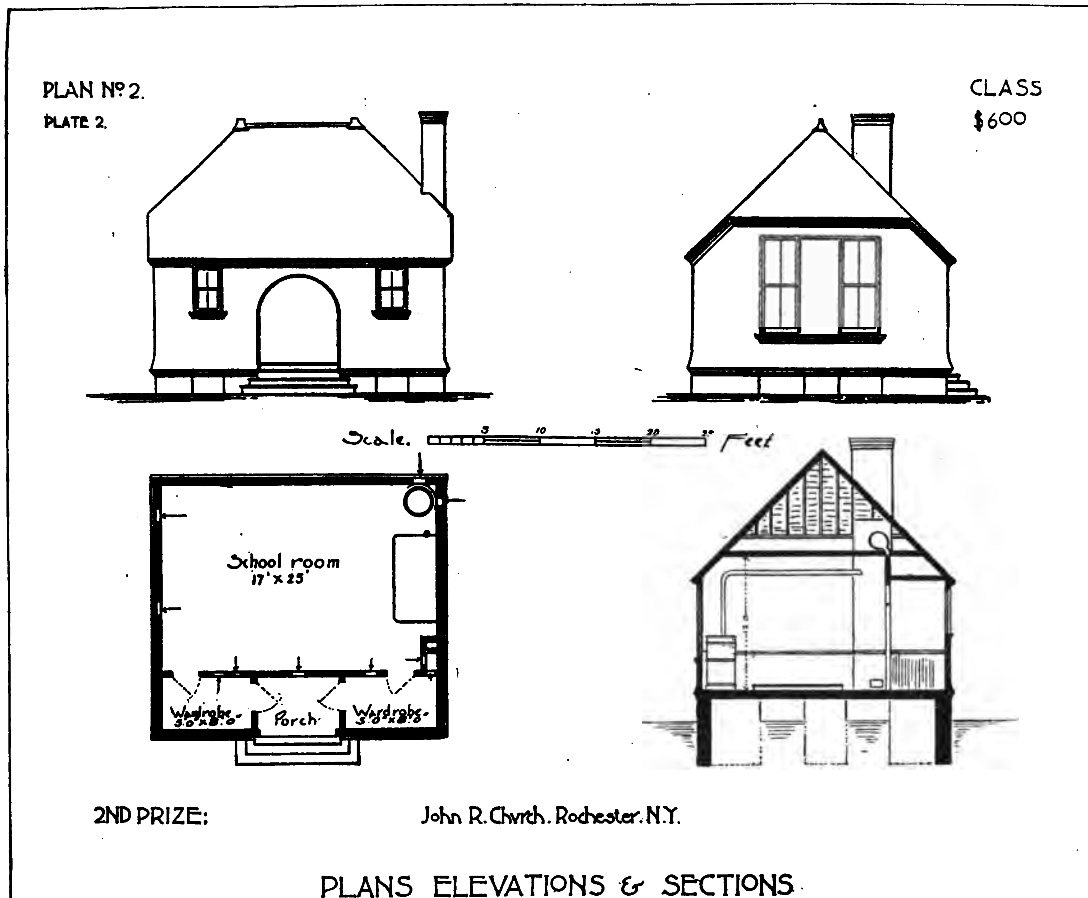
CLASS I.

$600

PERSPECTIVE

John R. Church. Rochester. N.Y.

Fig. 9.



PLAN No 2.
PLATE 2.
CLASS
$600
Scale.
5
10
15
20
25
Feet
School room
17'x25'
Wardrobe.
3.0x8.0
Porch
Wardrobe.
3.0x8.0
2ND PRIZE:
John R. Church. Rochester. N.Y.
PLANS ELEVATIONS & SECTIONS

Fig. 10.

PLAN Nº 3

PLATE I

CLASS I

PERSPECTIVE

SPECIAL COMMENDATION; John Cox. Jr. 259 West 23rd St.

ESTIMATED COST $800

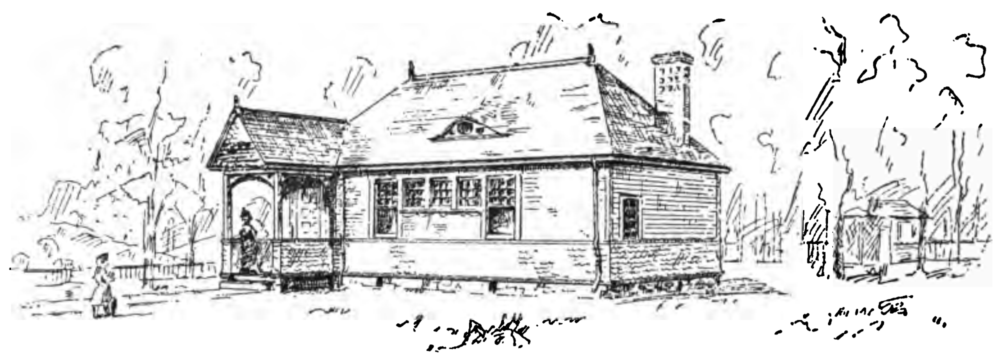
Fig. 11.


PLAN No 3
PLATE 2
SPECIAL COMMENDATION:
ESTIMATED COST $800
John Cox. Jr. 259 West 23rd St.
CLASS I.
AIR DUCT
SCHOOL ROOM
21'-6" × 28'-0"
GIRLS HALL
6'-6" × 12'-4"
TEACHERS ROOM
BOYS HALL
6'-6" × 12'-4"
PORCH
8' × 14'-8"
PLANS
ELEVATIONS & SECTIONS
SCALE 0 5 10 15 20 25 FEET

Fig. 12.

PLAN No. 4.

PLATE 1



PERSPECTIVE

ESTIMATED COST $700 Clarence Trve. Yonkers. N.Y.

Fig. 13.

PLAN Nº 2.
PLATE I.

CLASS I.
$600

PERSPECTIVE

John R. Church. Rochester. N.Y.

Fig. 9.

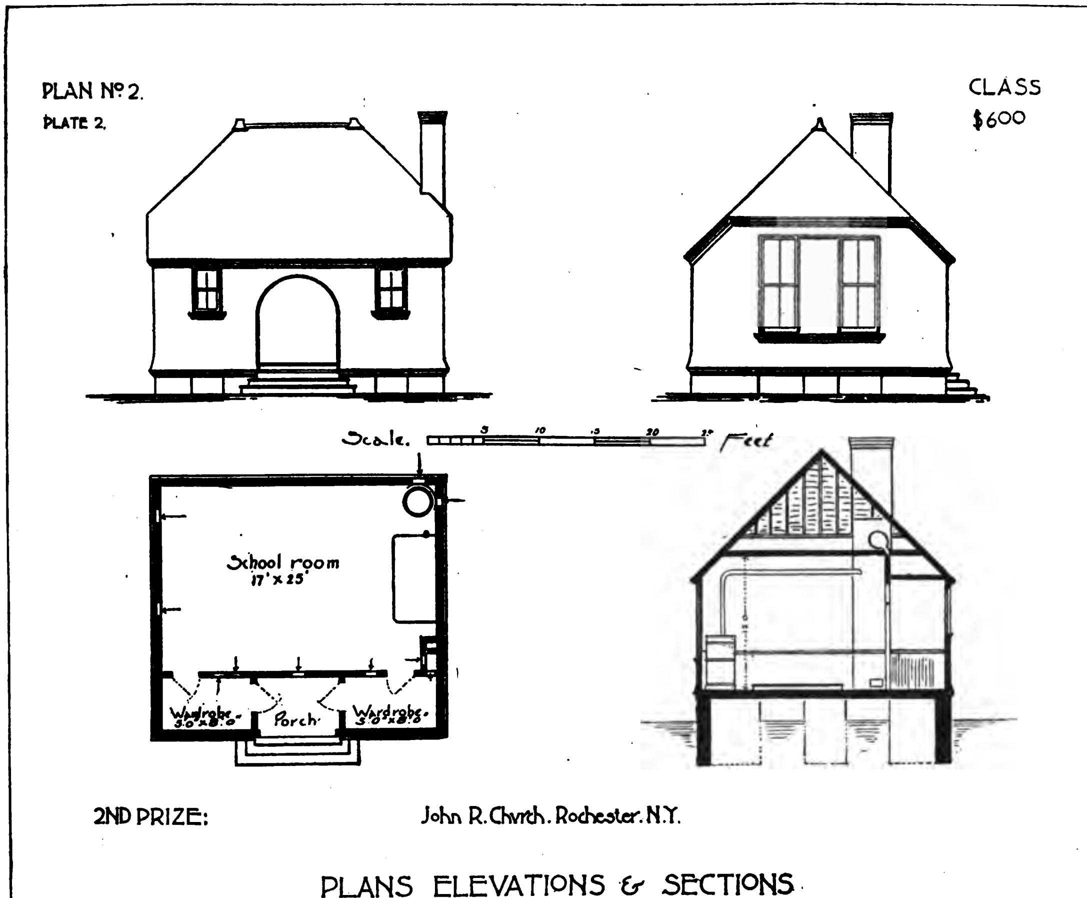

PLAN No. 2.
PLATE 2.
CLASS
$600
Scale.
5
10
15
20
25
Feet
School room
17' x 25'
Wardrobe.
3.0 x 8.0
Porch.
Wardrobe.
3.0 x 8.0
2ND PRIZE:
John R. Church. Rochester. N.Y.
PLANS ELEVATIONS & SECTIONS.

Fig. 10.

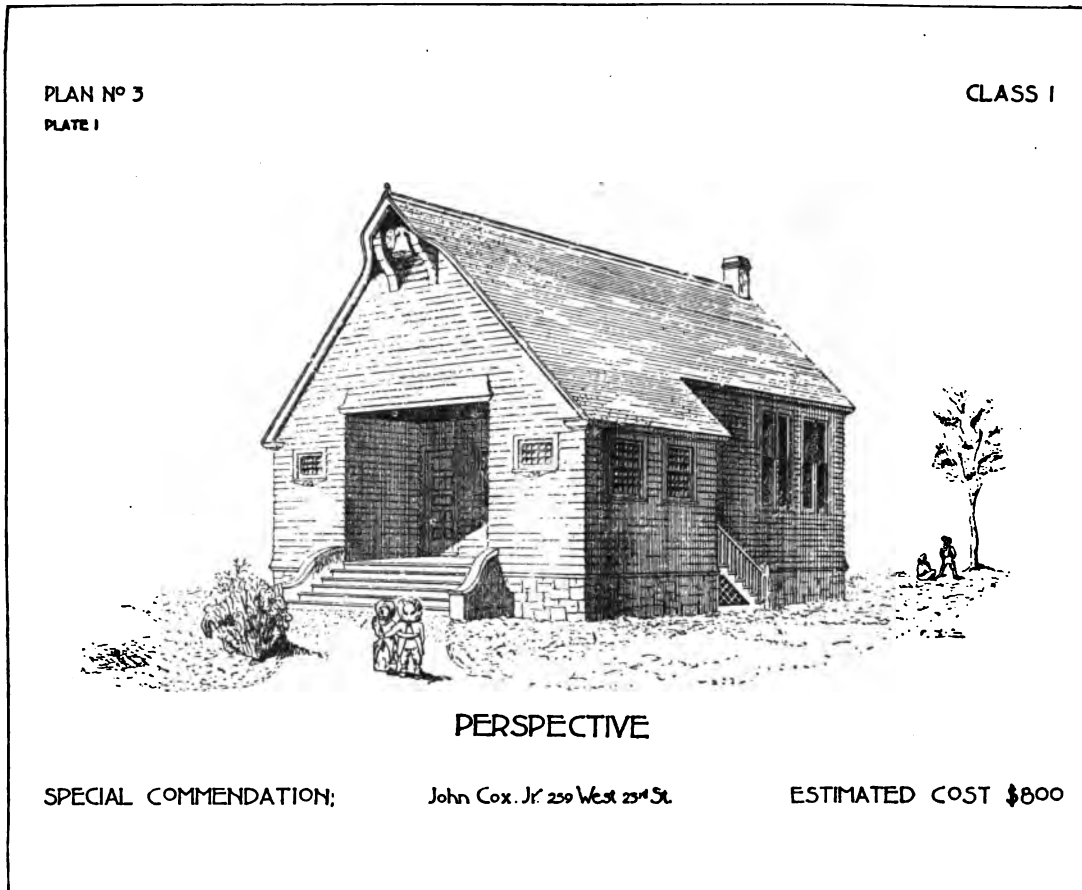

PLAN Nº 3
PLATE I
CLASS I
PERSPECTIVE
SPECIAL COMMENDATION;
John Cox. Jr. 259 West 23rd St.
ESTIMATED COST $800

Fig. 11.

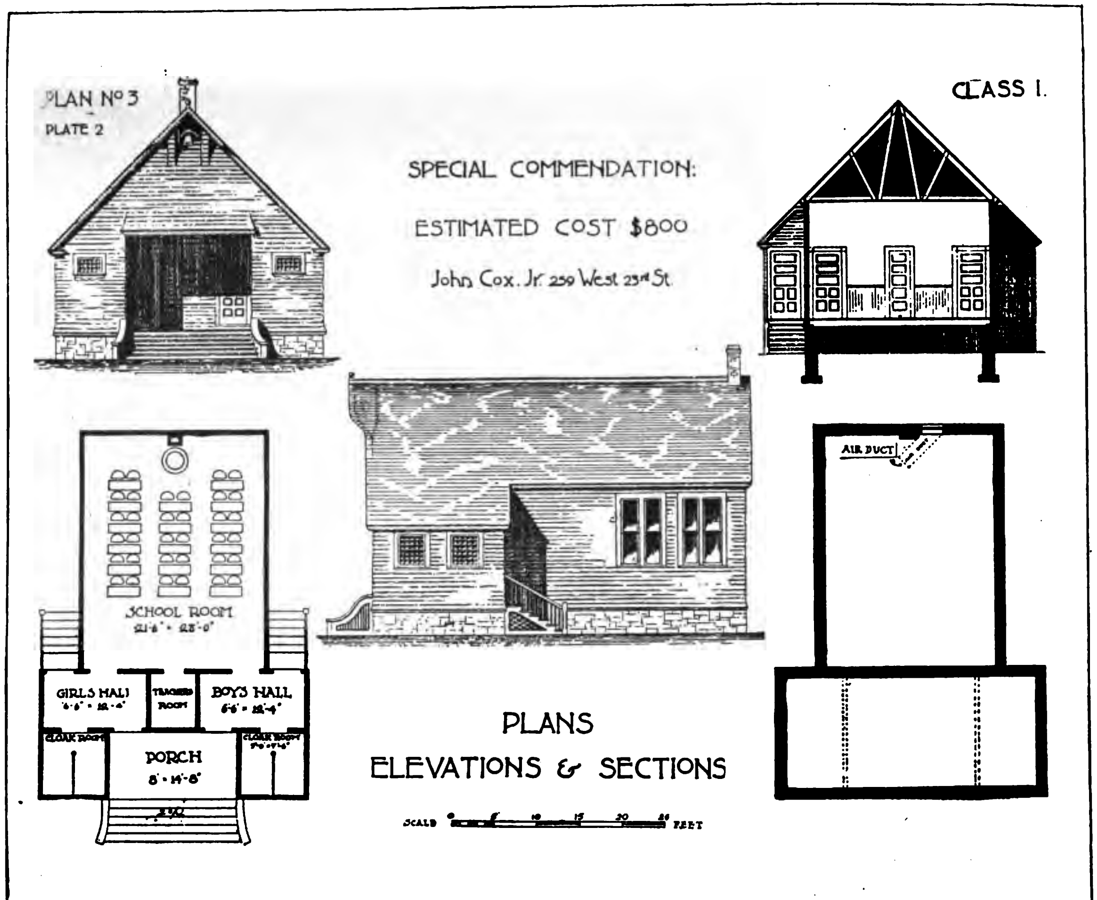

PLAN No 3
PLATE 2
SPECIAL COMMENDATION:
ESTIMATED COST $800
John Cox. Jr. 250 West 23rd St.
CLASS I.
AIR DUCT
SCHOOL ROOM
21'-6" × 25'-0"
GIRLS HALL
BOYS HALL
PORCH
8' × 14'-8"
PLANS
ELEVATIONS & SECTIONS
SCALE
FEET

Fig. 12.

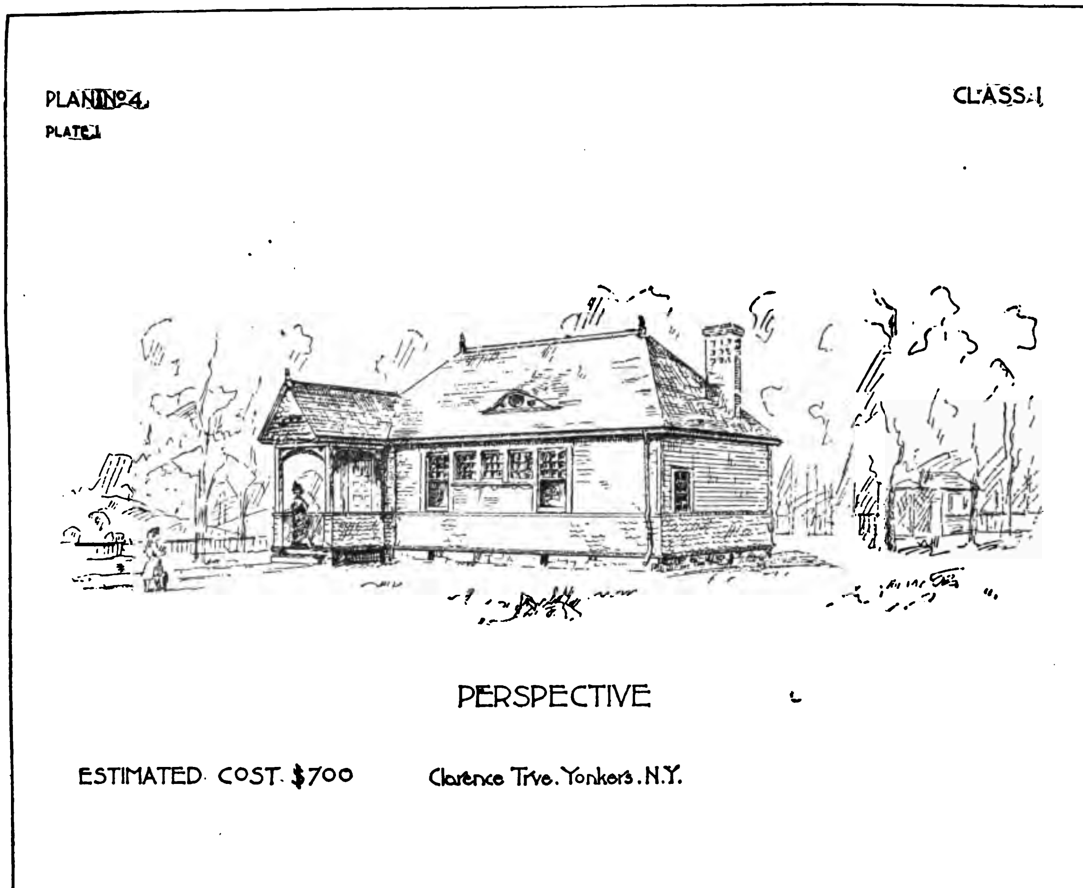

PLAN No 4.
PLATE I
CLASS I
PERSPECTIVE
ESTIMATED COST $700
Clarence Trve. Yonkers. N.Y.

Fig. 13.

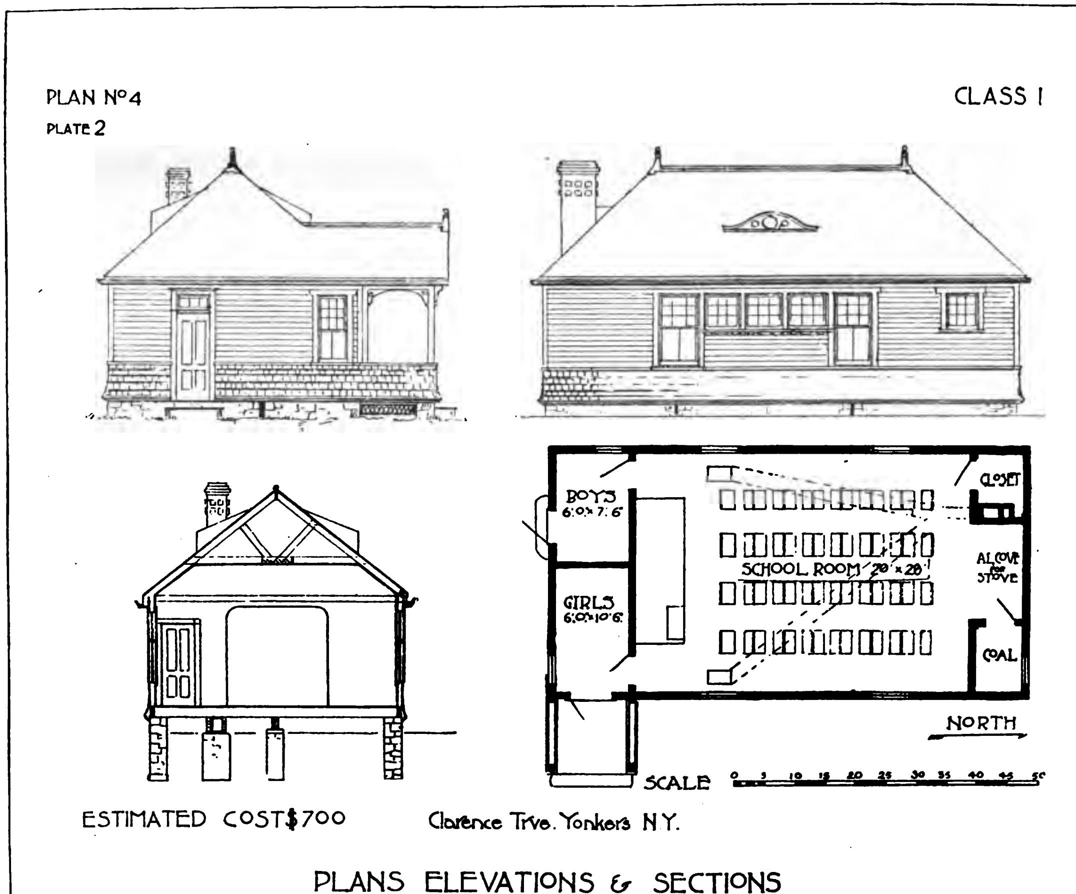

PLAN No 4
PLATE 2
CLASS I
BOYS 6:0"x 7:6"
GIRLS 6:0"x 10'6"
SCHOOL ROOM 20' x 28'
CLOSET
ALCOVE for STOVE
COAL
NORTH
SCALE 0 5 10 15 20 25 30 35 40 45 50
ESTIMATED COST $700
Clarence True. Yonkers N.Y.
PLANS ELEVATIONS & SECTIONS

Fig. 14.

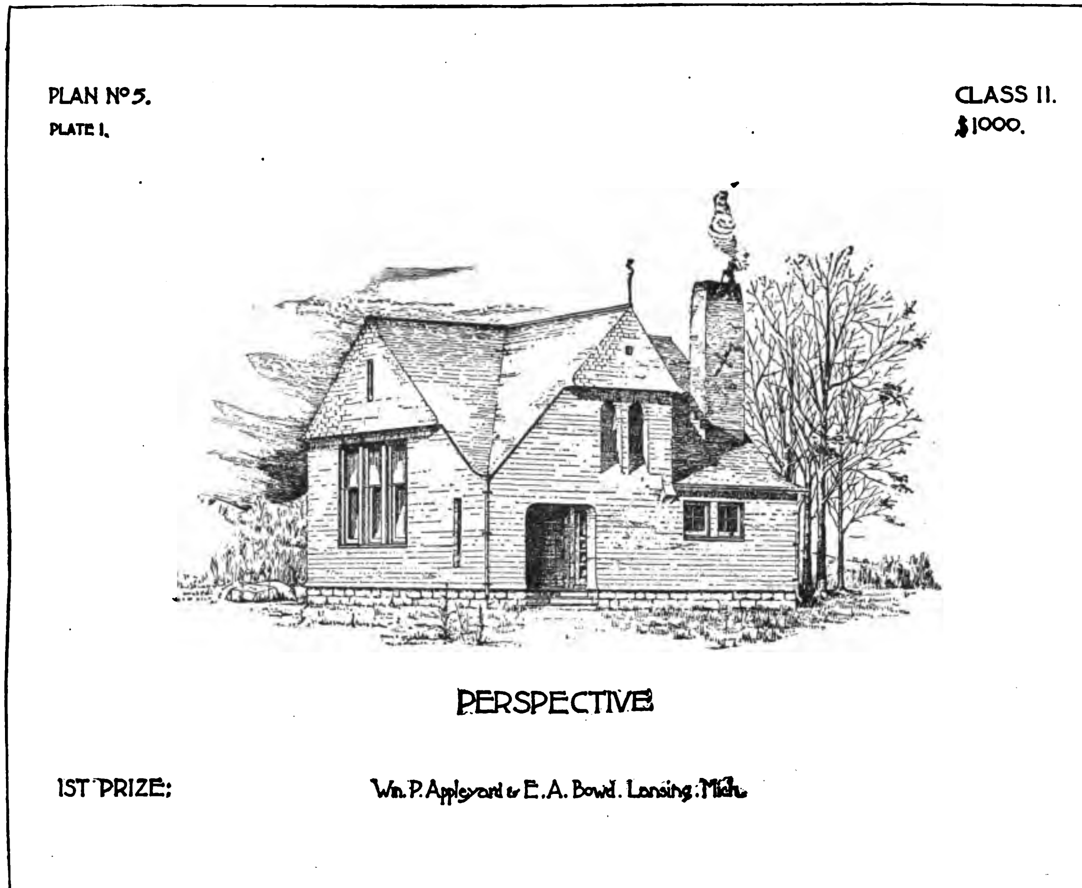

PLAN Nº 5.
PLATE I.
CLASS II.
$1000.
PERSPECTIVE
1ST PRIZE:
Wm. P. Appleyard & E. A. Bowd. Lansing: Mich.

Fig. 15.

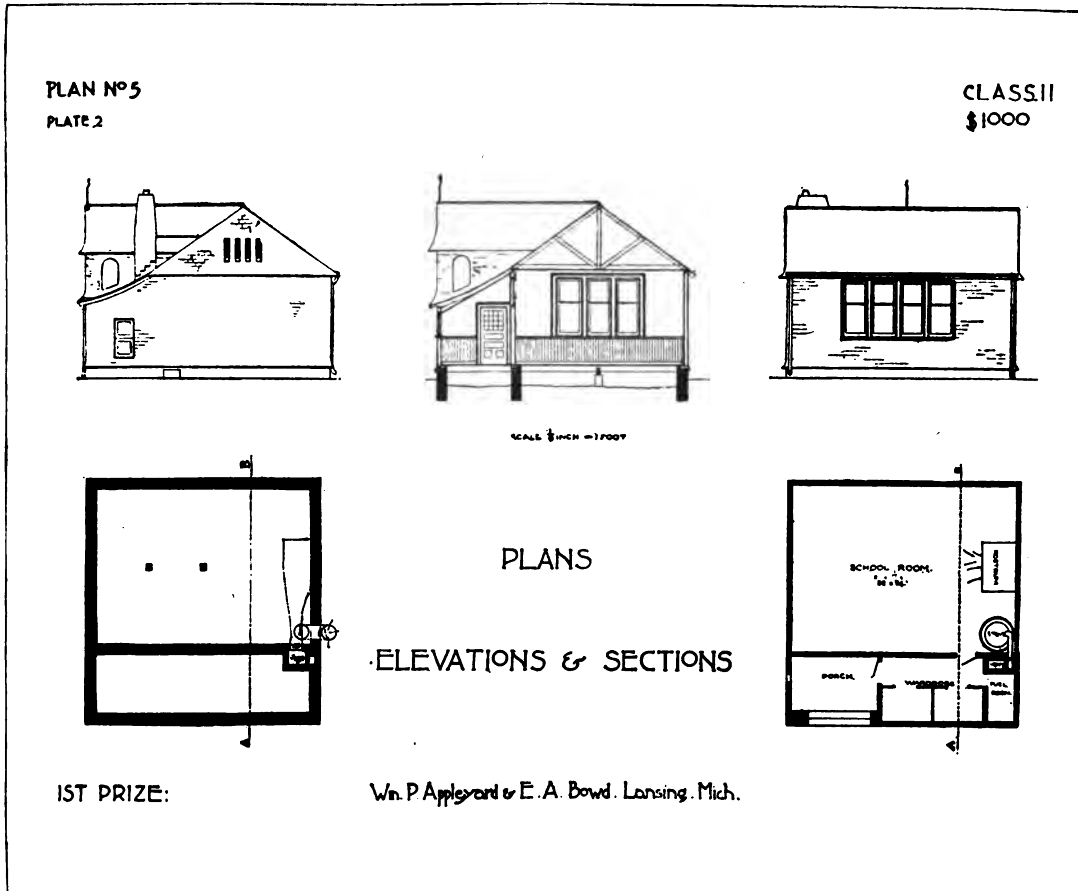
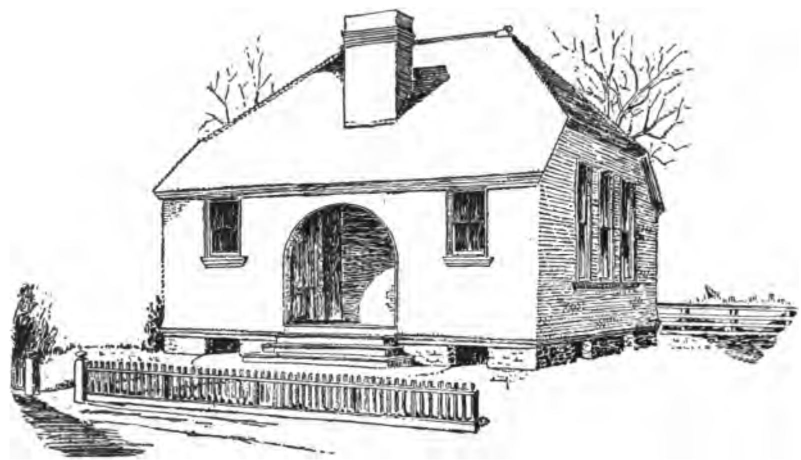

PLAN Nº 5
PLATE 2
CLASS II
$1000
SCALE ⅛ INCH = 1 FOOT
SCHOOL ROOM
PORCH
PLANS
ELEVATIONS & SECTIONS
1ST PRIZE:
Wm. P. Appleyard & E. A. Bowd. Lansing. Mich.

Fig. 16.

PLAN. Nº 6.
PLATE 1.

CLASS. II.
$1000.



PERSPECTIVE

2ND. PRIZE:

John R. Church. Rochester. N.Y.

Fig. 17.

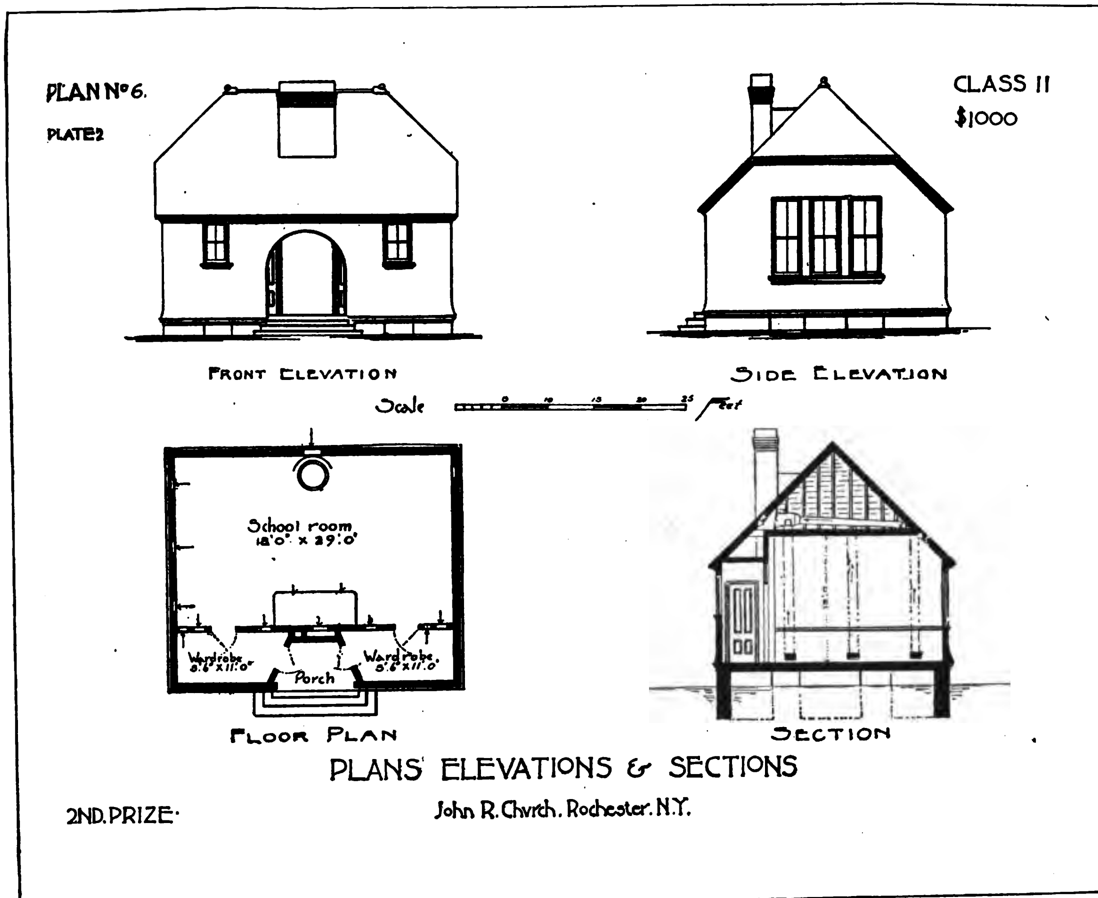
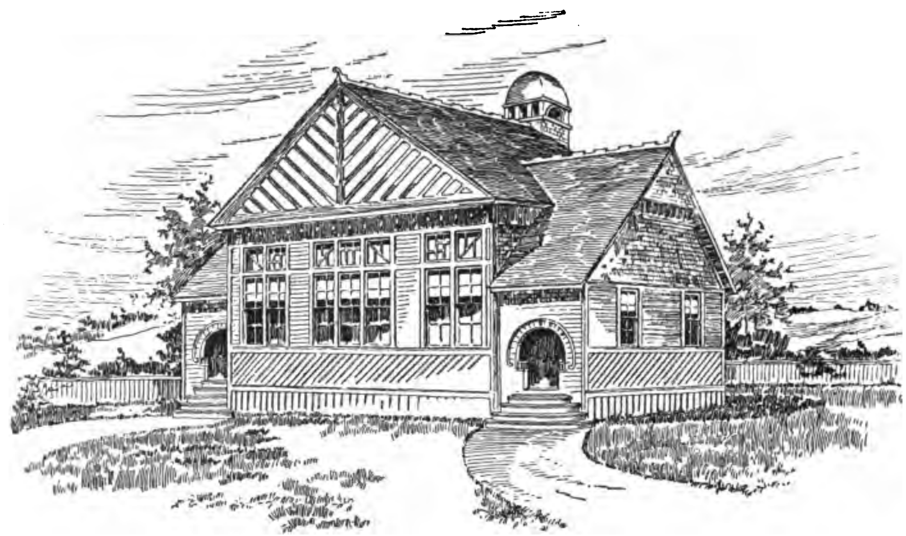

PLAN No 6.
PLATE 2
CLASS II
$1000
FRONT ELEVATION
SIDE ELEVATION
Scale
Feet
School room
18'0" x 29'0"
Wardrobe
8'6" x 11'0"
Porch
Wardrobe
8'6" x 11'0"
FLOOR PLAN
SECTION
PLANS ELEVATIONS & SECTIONS
John R. Church. Rochester. N.Y.
2ND. PRIZE

Fig. 18.

PLAN Nº 7. CLASS II

PLATE I.



PERSPECTIVE

SPECIAL COMMENDATION. C Powell Karr. Room 219 Stewart Bldg. New York City ESTIMATED COST $1200

Fig. 19.

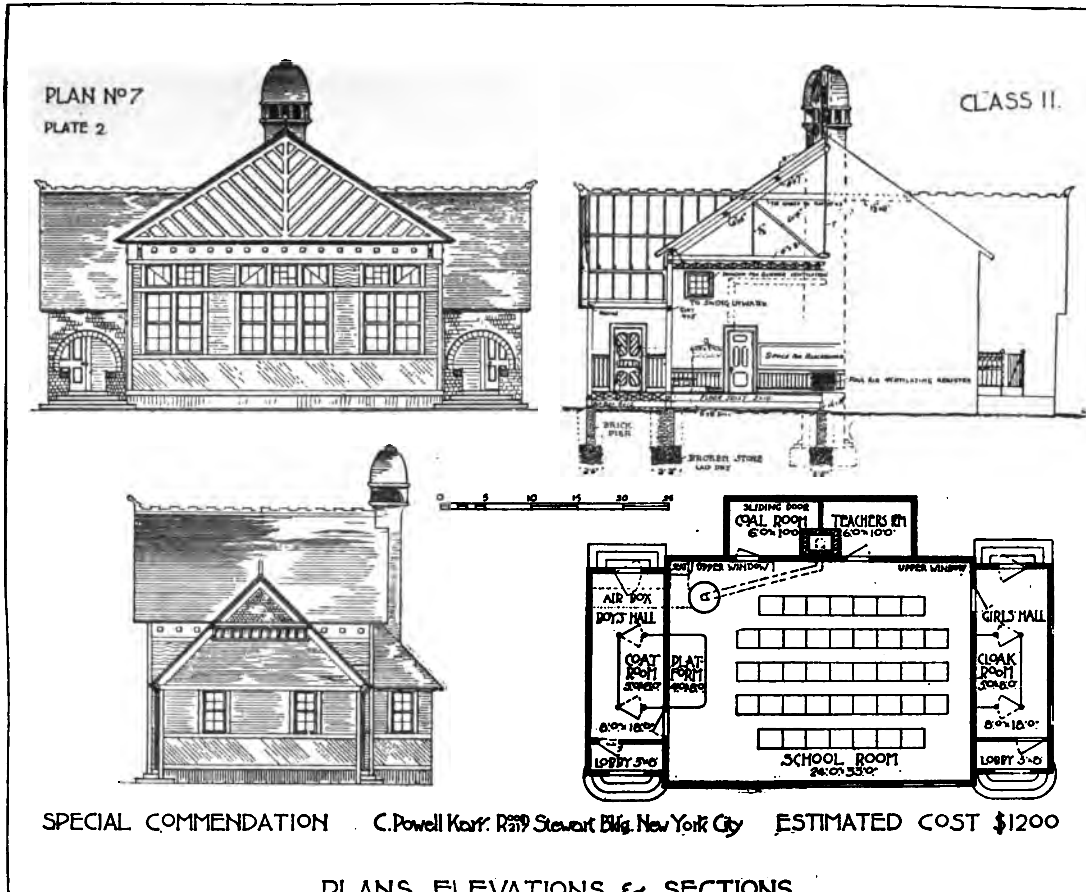

PLAN Nº7
PLATE 2
CLASS II.
BRICK PIER
BROKEN STONE
SLIDING DOOR
COAL ROOM 6'0"x10'0"
TEACHERS RM 6'0"x10'0"
UPPER WINDOW
UPPER WINDOW
AIR BOX
BOYS' HALL
COAT ROOM
PLATFORM
8'0"x18'0"
LOBBY 5'0"
SCHOOL ROOM 24'0"x35'0"
GIRLS' HALL
CLOAK ROOM
8'0"x18'0"
LOBBY 5'0"
SPECIAL COMMENDATION
C. Powell Karr. Room 219 Stewart Bldg. New York City
ESTIMATED COST $1200
PLANS ELEVATIONS & SECTIONS

Fig. 20.

PLAN Nº 8

PLATE I

CLASS II.

PERSPECTIVE

ESTIMATED COST $1100. J.C.A. Herlot & Corliss McKinney. Albany. N.Y.

Fig. 21.

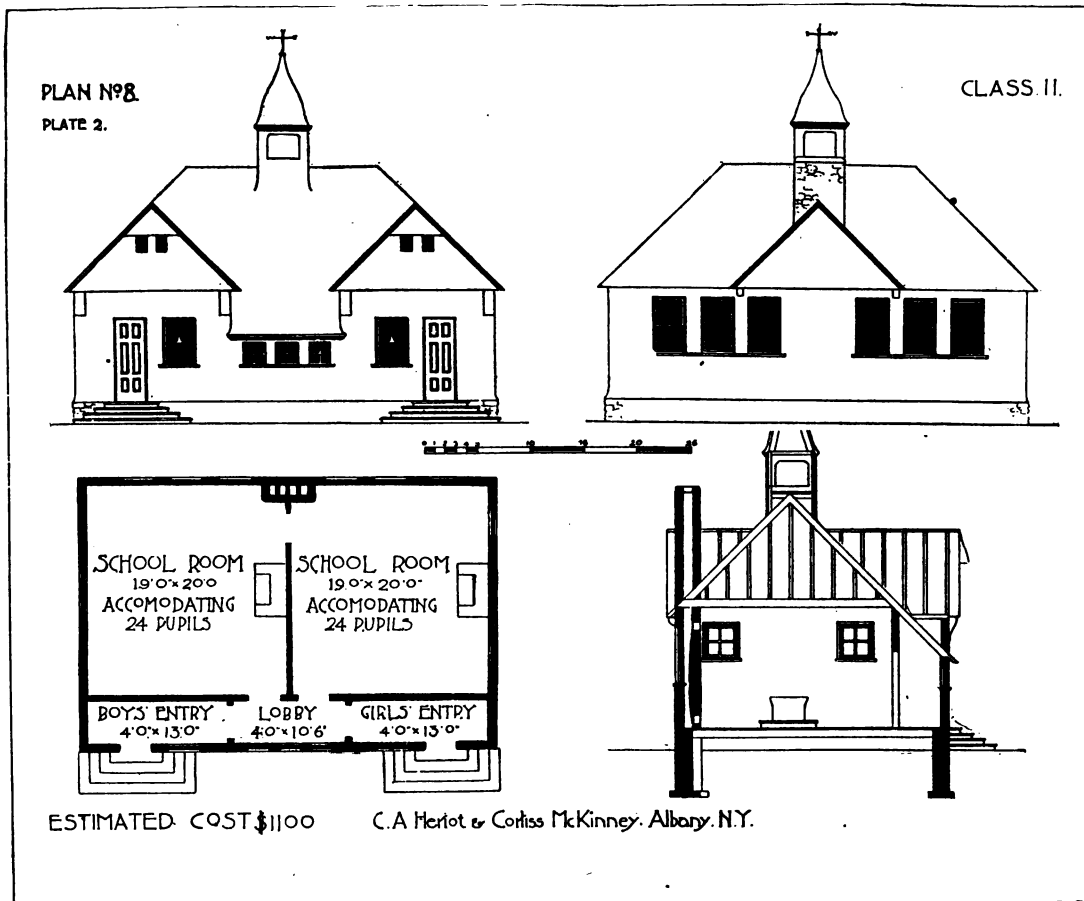

PLAN No 8.
PLATE 2.
CLASS II.
SCHOOL ROOM
19'0"×20'0"
ACCOMODATING
24 PUPILS
SCHOOL ROOM
19'0"×20'0"
ACCOMODATING
24 PUPILS
BOYS' ENTRY
4'0"×13'0"
LOBBY
4'0"×10'6"
GIRLS' ENTRY
4'0"×13'0"
ESTIMATED COST $1100
C.A Heriot & Corliss McKinney. Albany. N.Y.

Fig. 22.

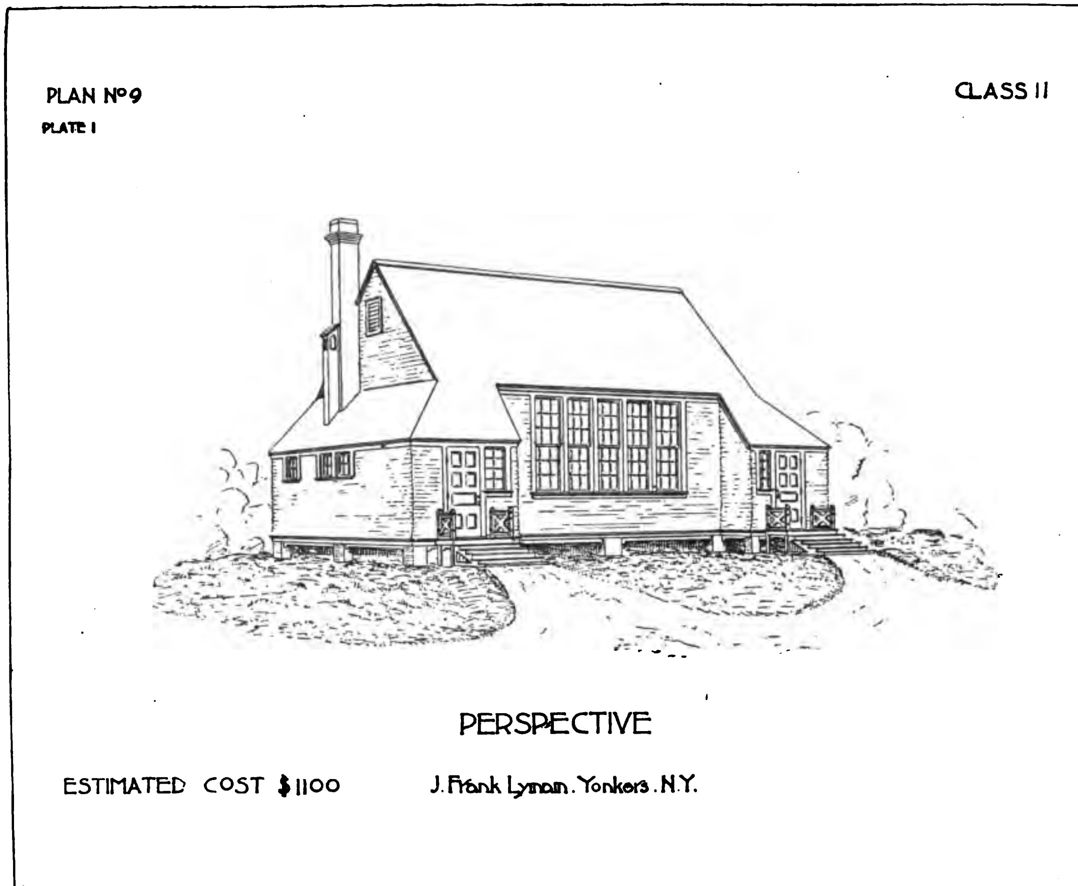

PLAN Nº 9
PLATE I
CLASS II
PERSPECTIVE
ESTIMATED COST $1100
J. Frank Lyman. Yonkers. N.Y.

Fig. 23.

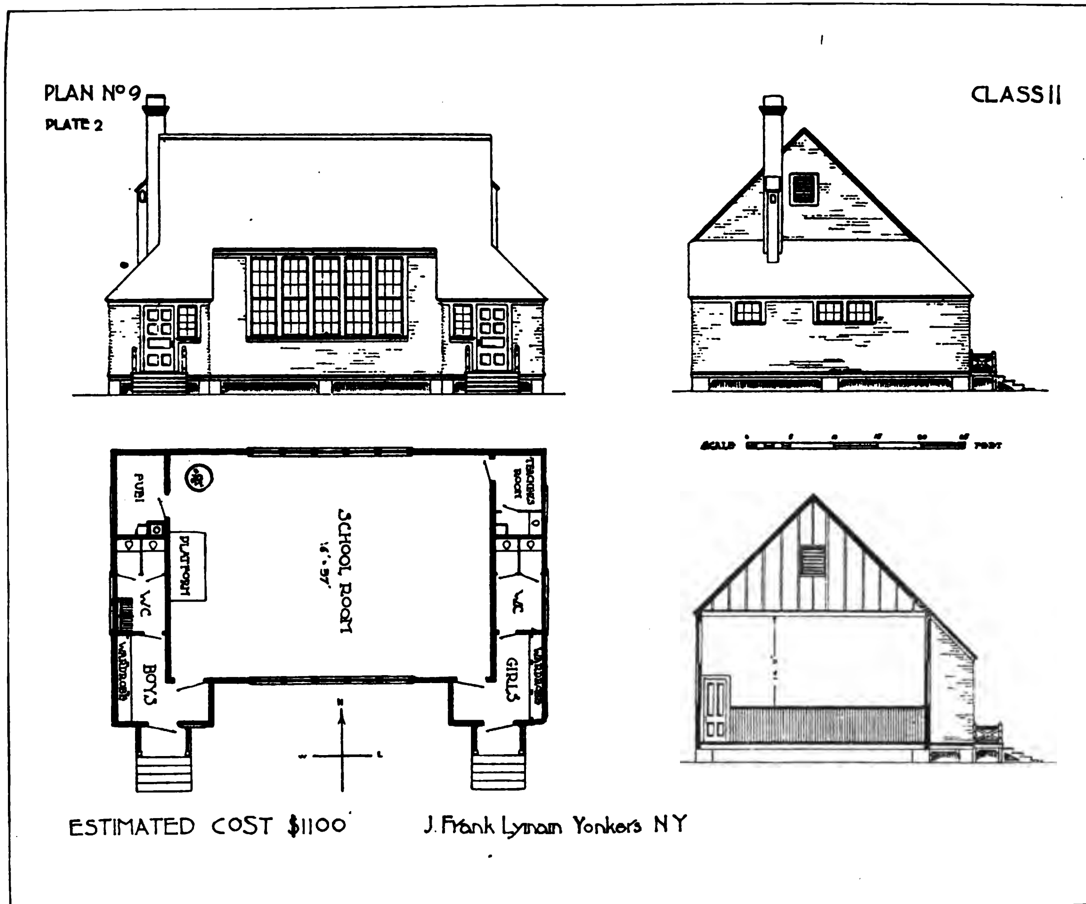

PLAN No 9
PLATE 2
CLASS II
SCHOOL ROOM
16' x 37'
TEACHERS ROOM
WC
GIRLS
WARDROBE
PLATFORM
PUBL
BOYS
ESTIMATED COST $1100
J. Frank Lyman Yonkers NY

Fig. 4.

PLAN Nº 10
PLATE I

CLASS III.
$1500.

PERSPECTIVE

1ST. PRIZE: J. C. A. Herlot & Corliss McKinney. Albany. N.Y.

Fig. 25.

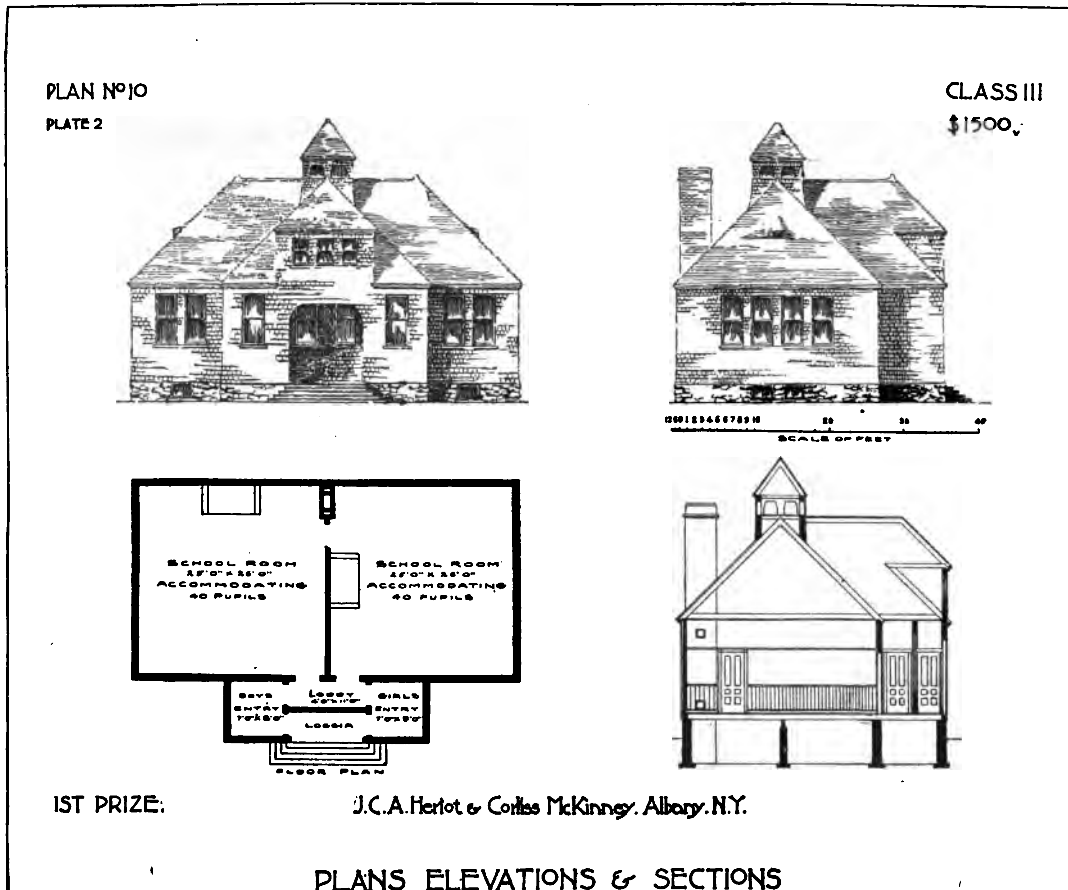

PLAN Nº 10
PLATE 2
CLASS III
$1500.
SCHOOL ROOM
ACCOMMODATING
40 PUPILS
SCHOOL ROOM
ACCOMMODATING
40 PUPILS
BOYS
ENTRY
LOBBY
GIRLS
ENTRY
LOGGIA
FLOOR PLAN
SCALE OF FEET
1ST PRIZE:
J.C.A. Heriot & Corliss McKinney. Albany. N.Y.
PLANS ELEVATIONS & SECTIONS

Fig. 26.

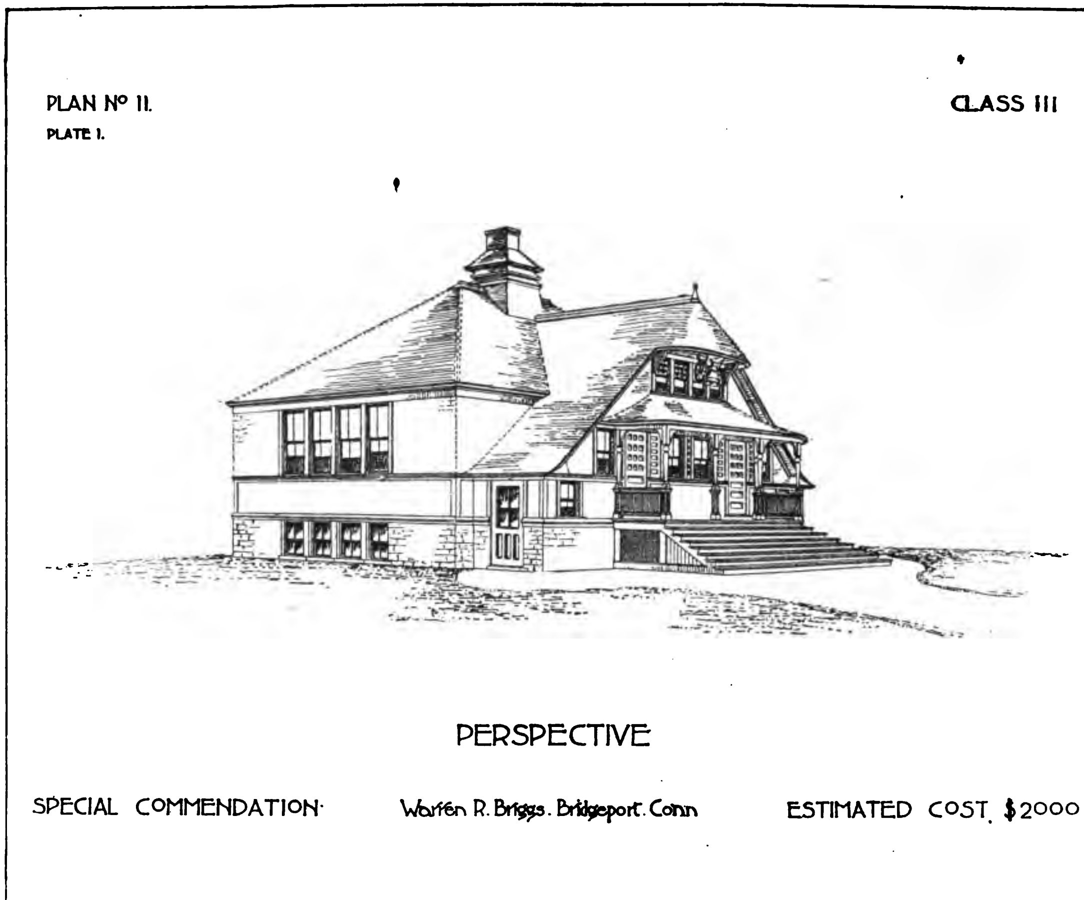
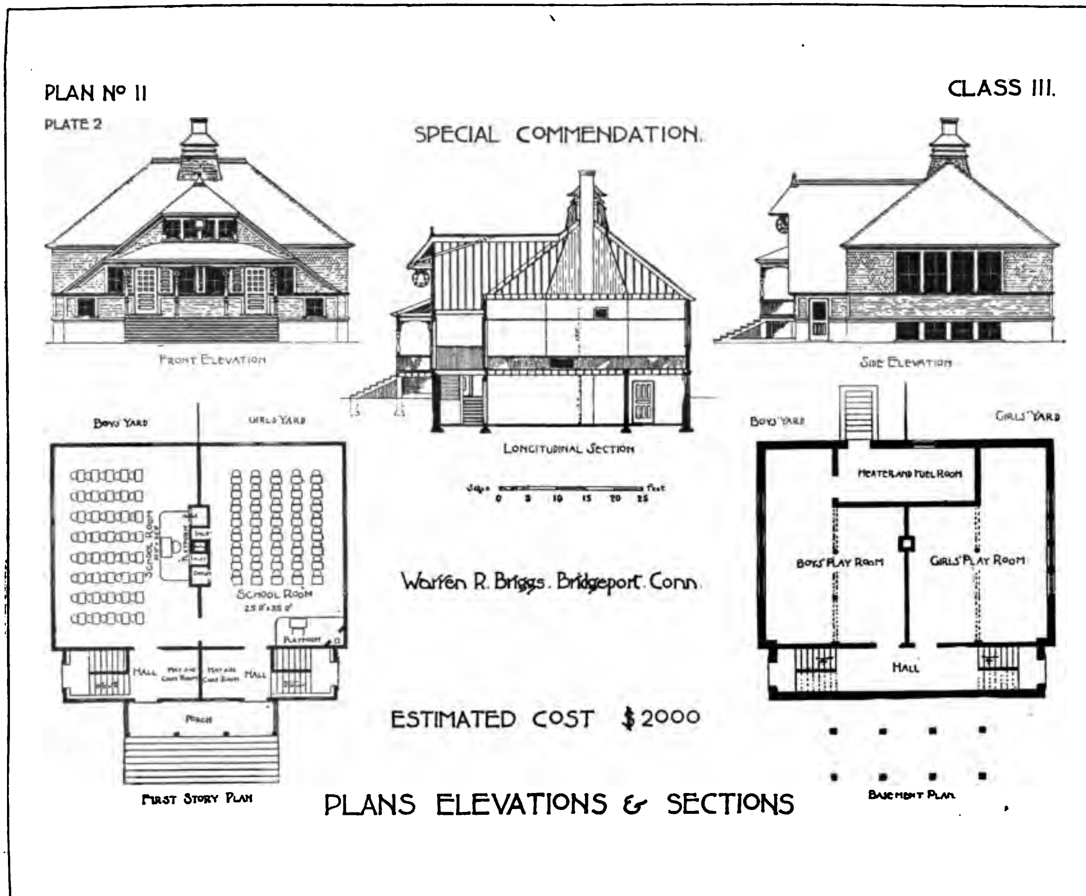

PLAN Nº 11.
PLATE 1.
CLASS III
PERSPECTIVE
SPECIAL COMMENDATION·
Warren R. Briggs. Bridgeport. Conn
ESTIMATED COST. $2000

Fig. 27.


PLAN No II
PLATE 2
CLASS III.
SPECIAL COMMENDATION.
FRONT ELEVATION
LONGITUDINAL SECTION
SIDE ELEVATION
BOYS YARD
GIRLS YARD
SCHOOL ROOM
SCHOOL ROOM
25 0" x 35 0"
PLATFORM
HALL
HALL
PORCH
FIRST STORY PLAN
Scale 0 5 10 15 20 25 Feet
Warren R. Briggs. Bridgeport. Conn.
ESTIMATED COST $2000
BOYS YARD
GIRLS YARD
HEATER AND FUEL ROOM
BOYS' PLAY ROOM
GIRLS' PLAY ROOM
HALL
BASEMENT PLAN
PLANS ELEVATIONS & SECTIONS

PLAN Nº 12
PLATE I

CLASS IV.

PERSPECTIVE

ESTIMATED COST $ 2500 J.C.A. Heriot & Corliss McKinney. Albany. N.Y.

Fig. 29.

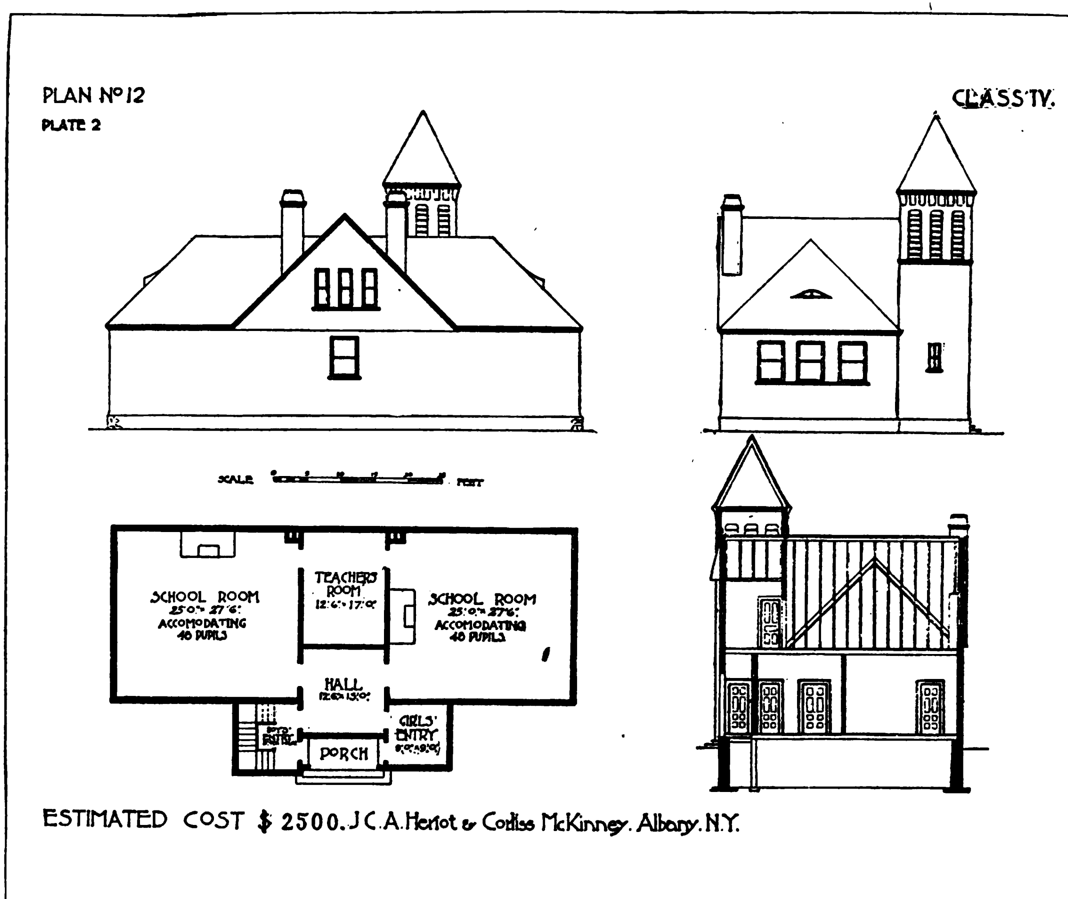

PLAN No 12
PLATE 2
CLASS IV.
SCALE FEET
SCHOOL ROOM
25'0" x 27'6"
ACCOMODATING
40 PUPILS
TEACHERS ROOM
12'6" x 17'0"
SCHOOL ROOM
25'0" x 27'6"
ACCOMODATING
40 PUPILS
HALL
12'6" x 13'0"
GIRLS' ENTRY
PORCH
ESTIMATED COST $ 2500. J C A. Heriot & Corliss McKinney. Albany. N.Y.

Fig. 30.

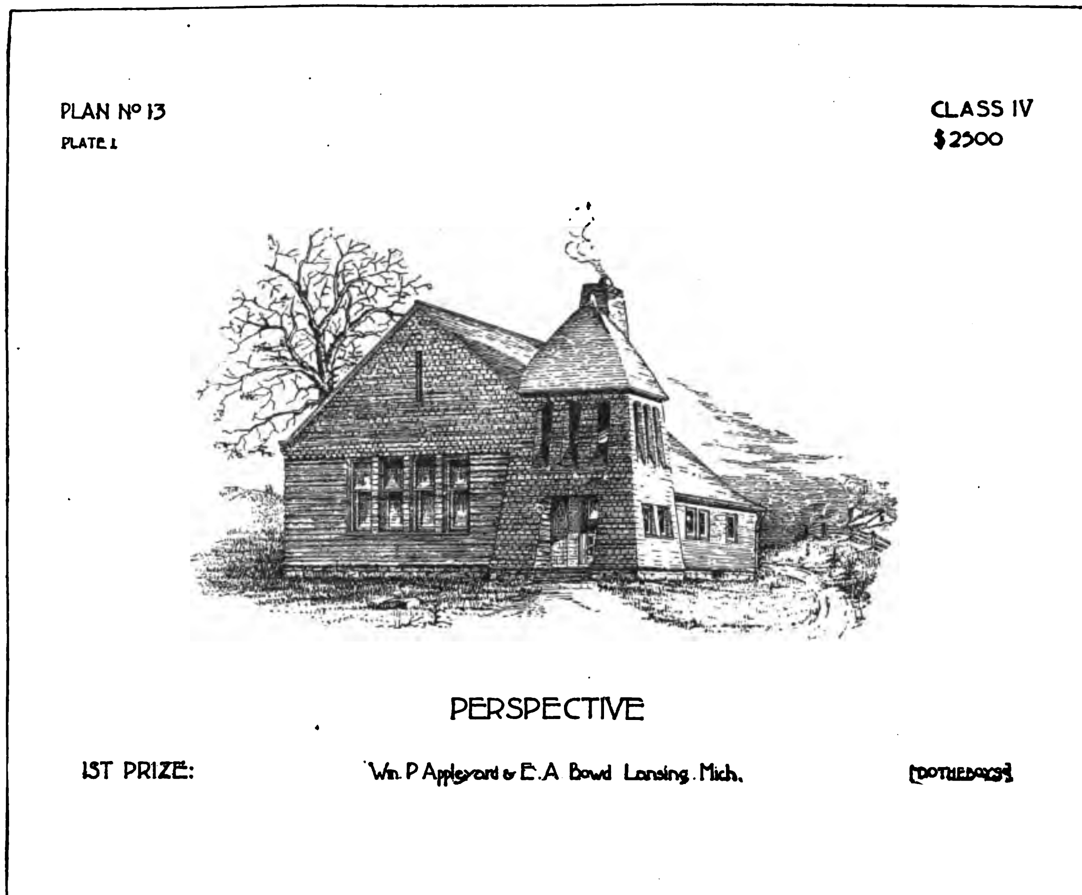

PLAN Nº 13
PLATE 1
CLASS IV
$2500
PERSPECTIVE
1ST PRIZE:
Wm. P Appleyard & E. A Bowd Lansing. Mich.

Fig. 31.

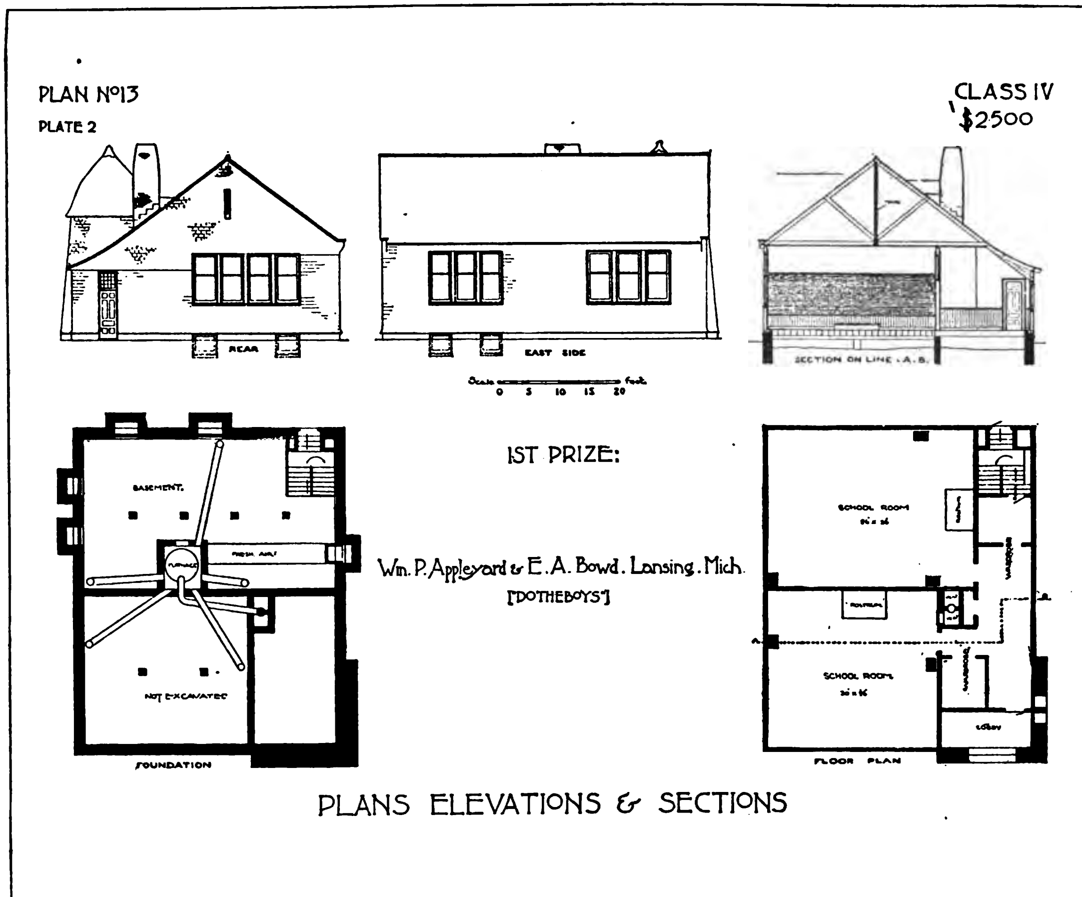

PLAN No13
PLATE 2
CLASS IV
$2500
REAR
EAST SIDE
SECTION ON LINE A.B.
Scale feet
0 5 10 15 20
BASEMENT.
FRESH AIR
FURNACE
NOT EXCAVATED
FOUNDATION
1ST PRIZE:
Wm. P. Appleyard & E.A. Bowd. Lansing. Mich.
[DOTHEBOYS]
SCHOOL ROOM
SCHOOL ROOM
LOBBY
FLOOR PLAN
PLANS ELEVATIONS & SECTIONS

Fig. 32.

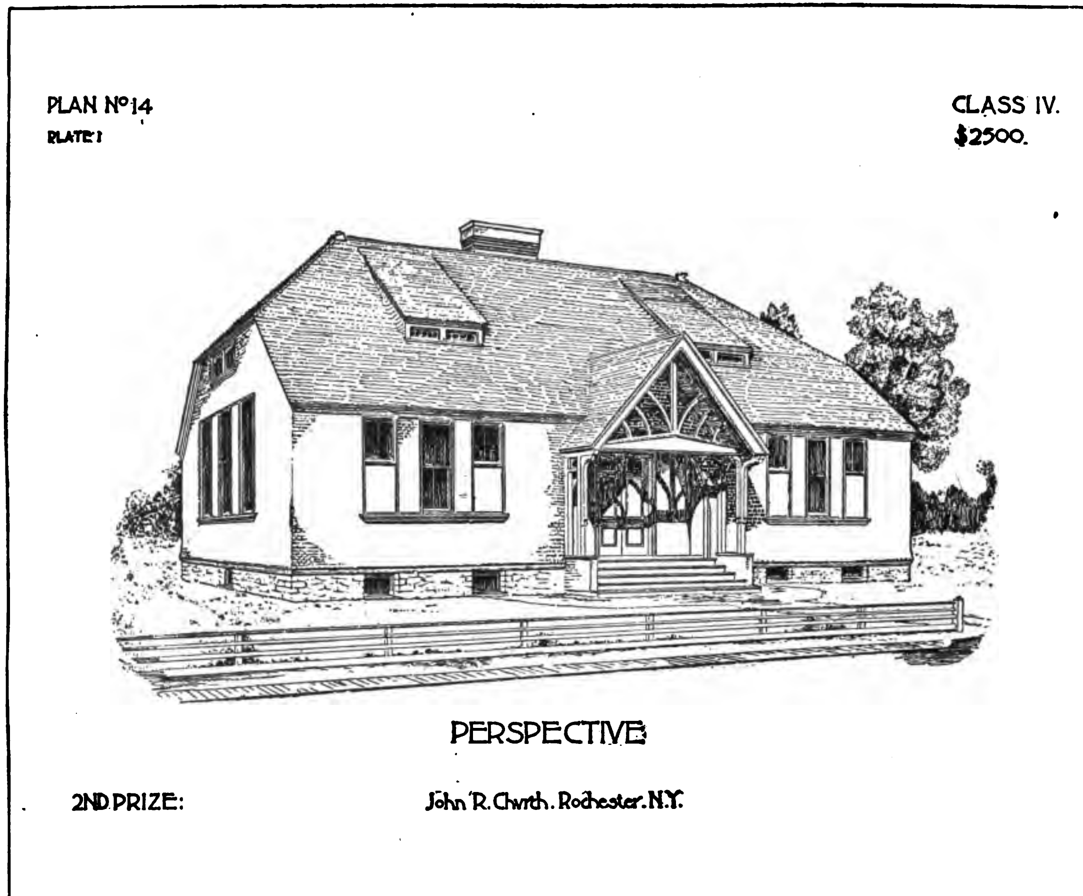

PLAN Nº 14
PLATE I
CLASS IV.
$2500.
PERSPECTIVE
2ND PRIZE:
John R. Church. Rochester. N.Y.

Fig. 33.

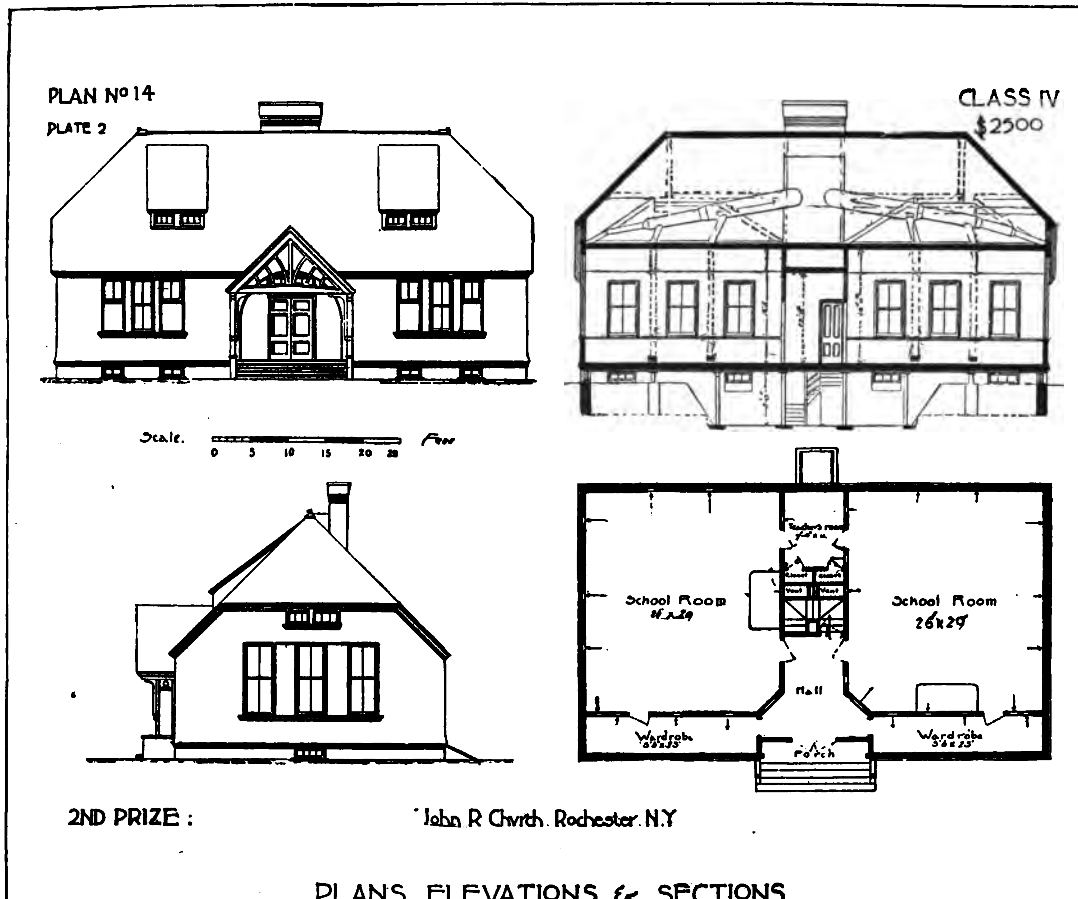

PLAN No 14
PLATE 2
CLASS IV
$2500
Scale.
0 5 10 15 20 25
Feet
School Room
School Room
26x29
Hall
Wardrobe
Wardrobe
Porch
2ND PRIZE :
John R Church. Rochester. N.Y
PLANS ELEVATIONS & SECTIONS

Fig. 34.

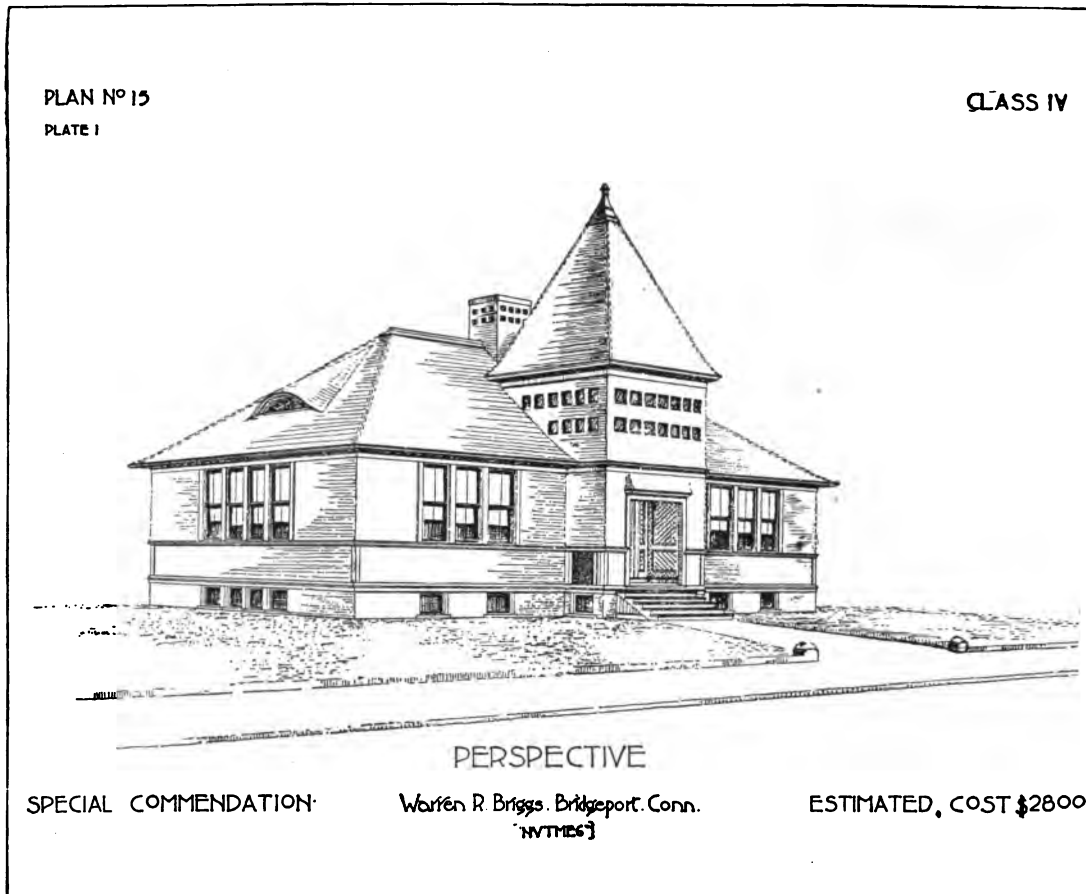

PLAN Nº 15
PLATE I
CLASS IV
PERSPECTIVE
SPECIAL COMMENDATION·
Warren R. Briggs. Bridgeport. Conn.
"NUTMEG"
ESTIMATED, COST $2800

Fig. 35.

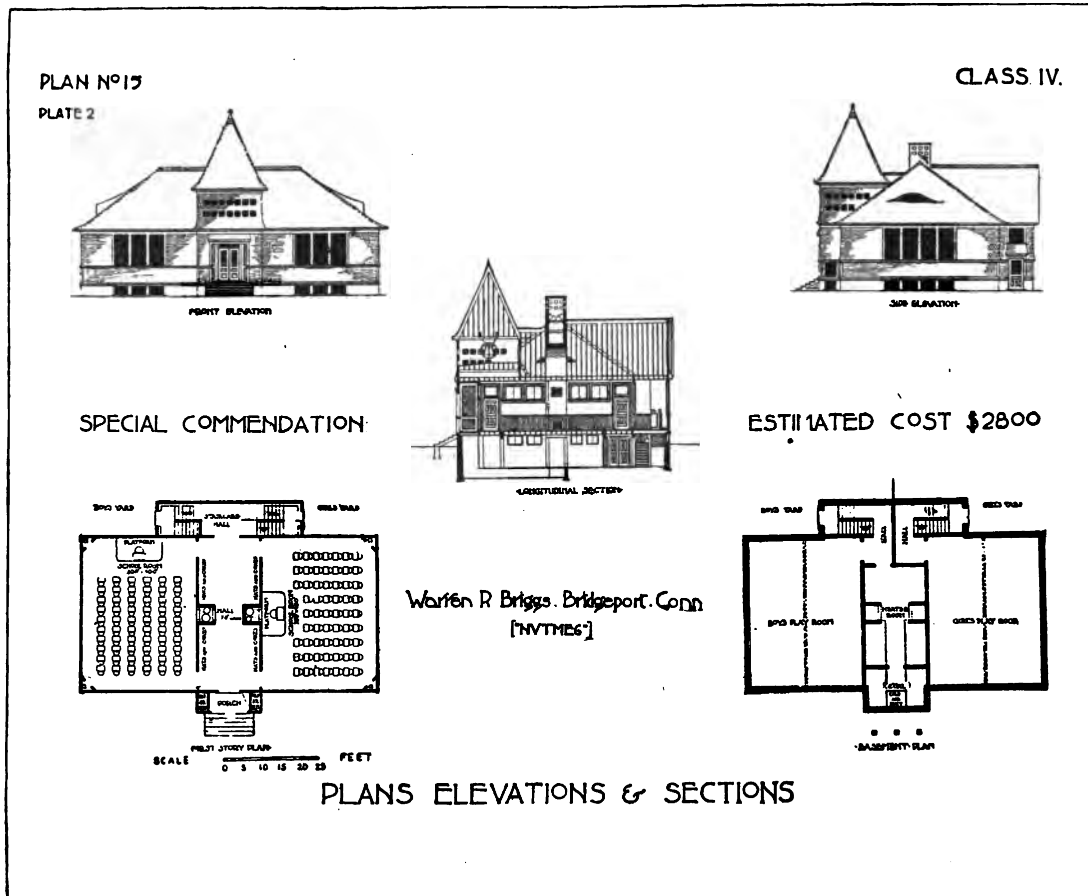
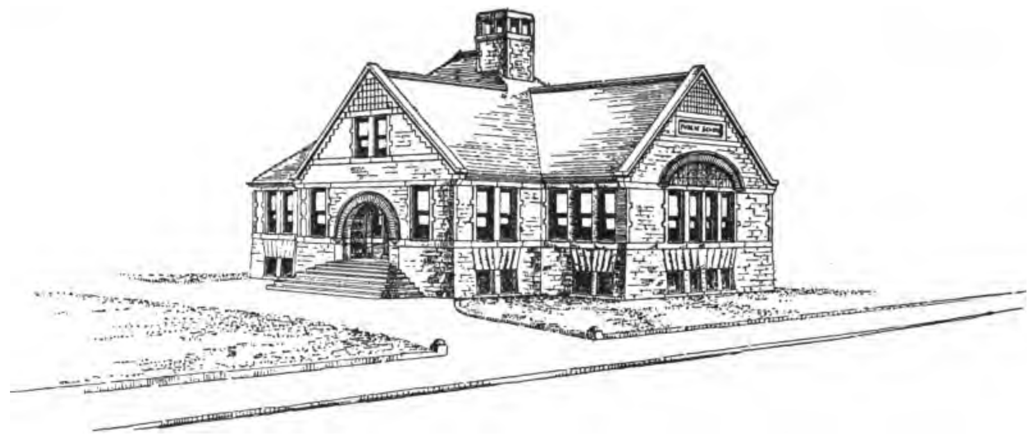

PLAN No 15
PLATE 2
CLASS IV.
FRONT ELEVATION
SIDE ELEVATION
LONGITUDINAL SECTION
SPECIAL COMMENDATION
ESTIMATED COST $2800
Warren R Briggs. Bridgeport. Conn
["NUTMEG"]
FIRST STORY PLAN
BASEMENT PLAN
SCALE
0 5 10 15 20 25
FEET
PLANS ELEVATIONS & SECTIONS

Fig. 36.

PLAN No 16.
PLATE I

CLASS V



PERSPECTIVE

SPECIAL COMMENDATION. Warren R. Briggs. Bridgeport. Conn. ESTIMATED COST $6600

Fig. 37.

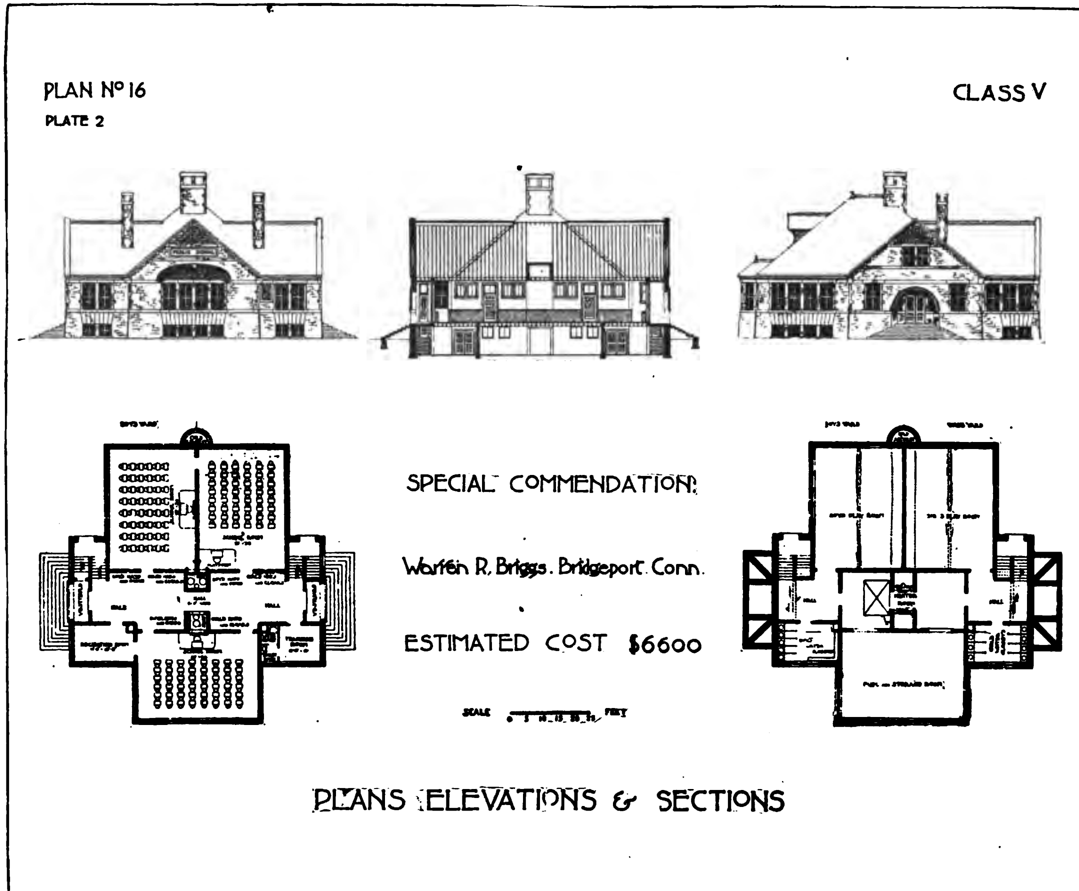

PLAN Nº 16
PLATE 2
CLASS V
SPECIAL COMMENDATION.
Warren R. Briggs. Bridgeport. Conn.
ESTIMATED COST $6600
PLANS ELEVATIONS & SECTIONS

Fig. 38.

PLAN Nº 17.
PLATE I.

CLASS V.

PERSPECTIVE

SPECIAL COMMENDATION: Fenimore C. Bate. 29 Euclid Ave. Cleveland. O. ESTIMATED COST $6900.

Fig. 39.

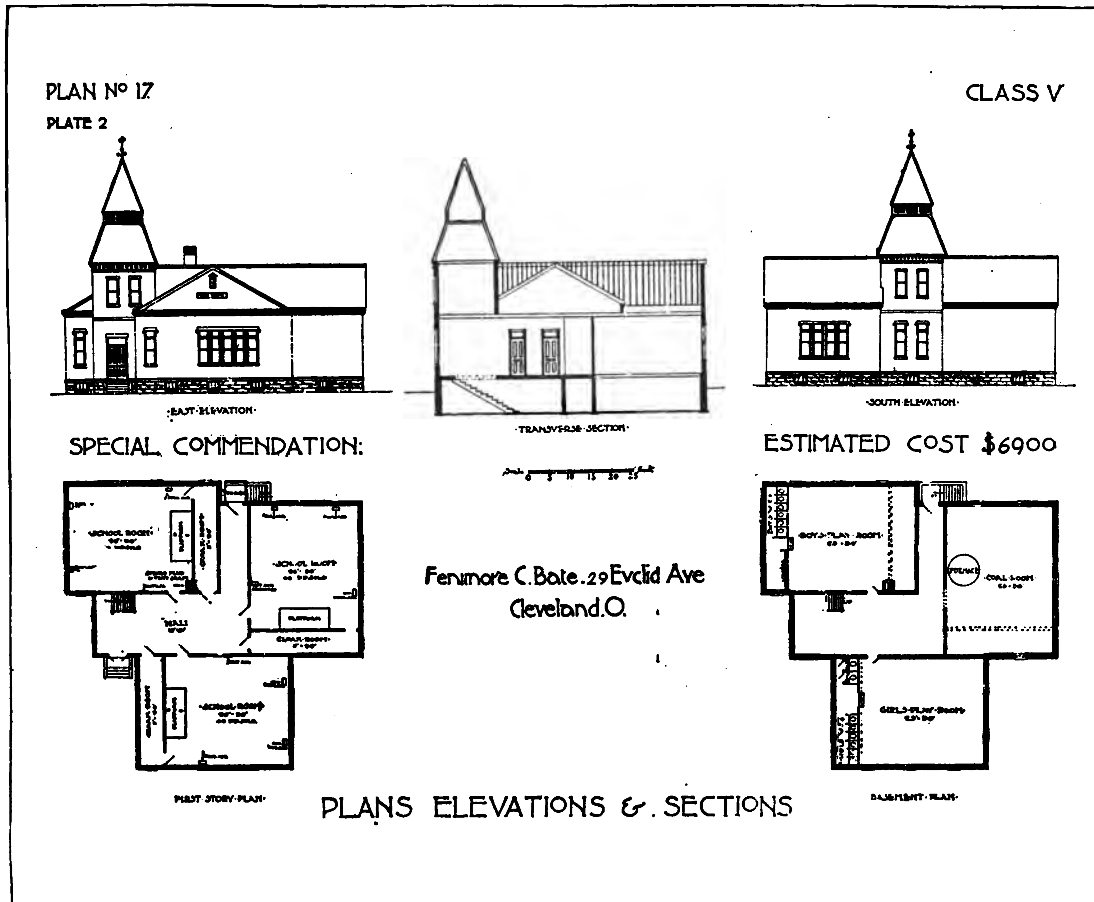

PLAN Nº 17
PLATE 2
CLASS V
·EAST·ELEVATION·
·TRANSVERSE·SECTION·
·SOUTH·ELEVATION·
SPECIAL COMMENDATION:
ESTIMATED COST $6900
Fenimore C. Bate. 29 Euclid Ave
Cleveland. O.
·FIRST·STORY·PLAN·
·BASEMENT·PLAN·
PLANS ELEVATIONS & . SECTIONS

Fig. 40.

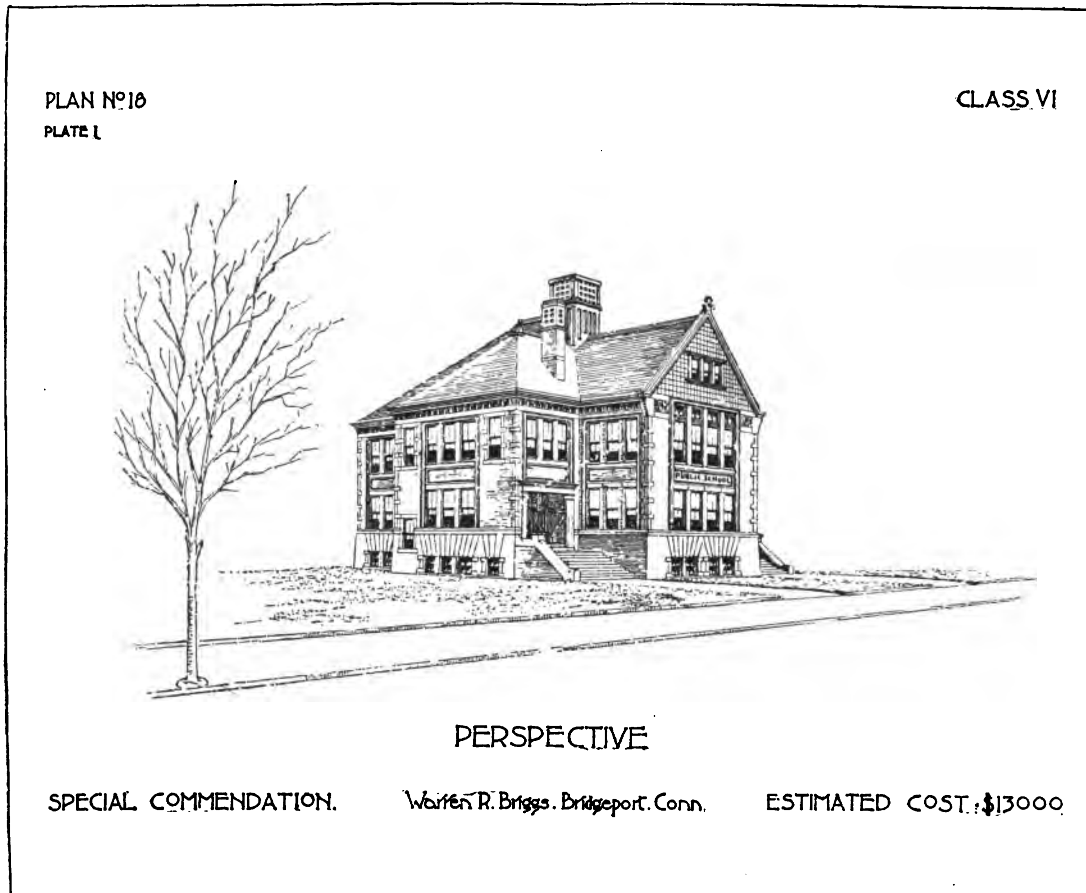

PLAN No 18
PLATE I
CLASS VI
PERSPECTIVE
SPECIAL COMMENDATION.
Warren R. Briggs. Bridgeport. Conn.
ESTIMATED COST: $13000

Fig. 41.

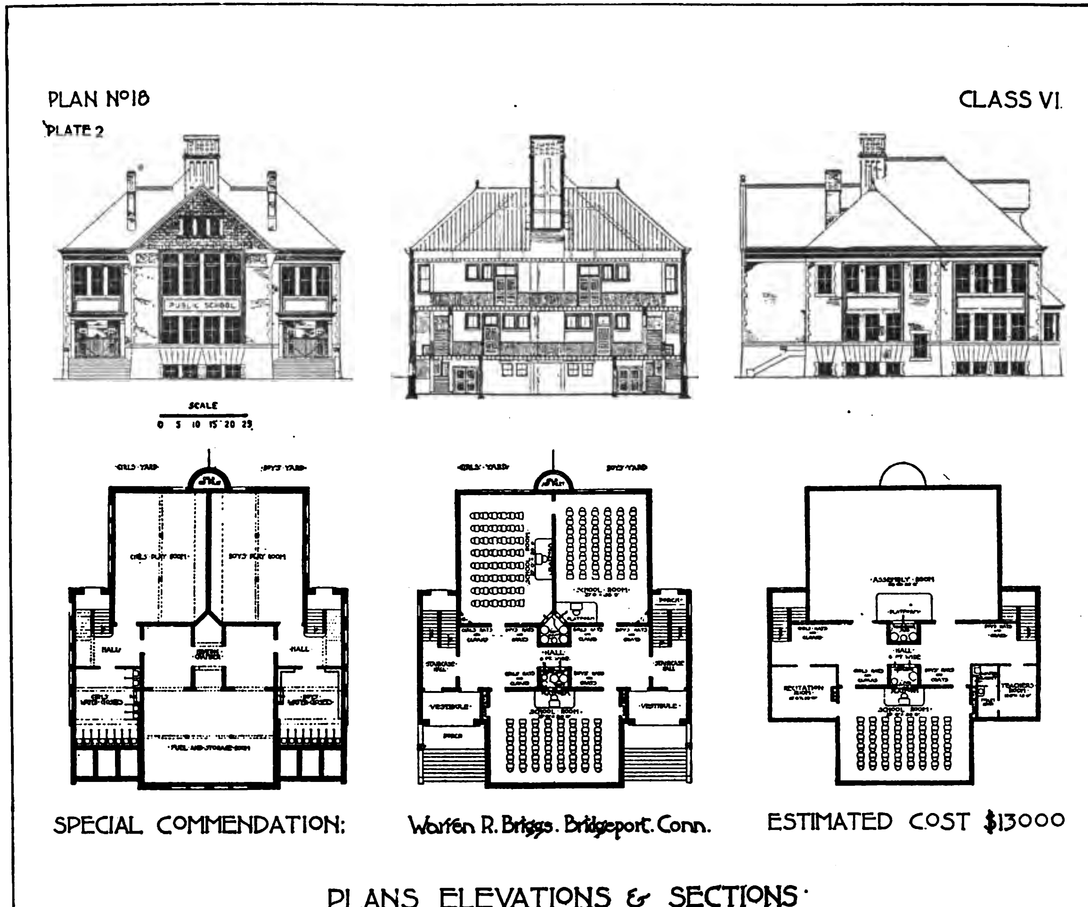

PLAN No 18
PLATE 2
CLASS VI.
PUBLIC SCHOOL
SCALE
0 5 10 15 20 25
GIRLS' YARD
BOYS' YARD
GIRLS' PLAY ROOM
BOYS' PLAY ROOM
HALL
HALL
FUEL AND STORAGE ROOM
SCHOOL ROOM
HALL
VESTIBULE
VESTIBULE
STAIRCASE HALL
STAIRCASE HALL
PORCH
PORCH
ASSEMBLY ROOM
PLATFORM
HALL
RECITATION ROOM
TEACHERS' ROOM
SCHOOL ROOM
SPECIAL COMMENDATION:
Warren R. Briggs. Bridgeport. Conn.
ESTIMATED COST $13000
PLANS ELEVATIONS & SECTIONS

Fig. 42.

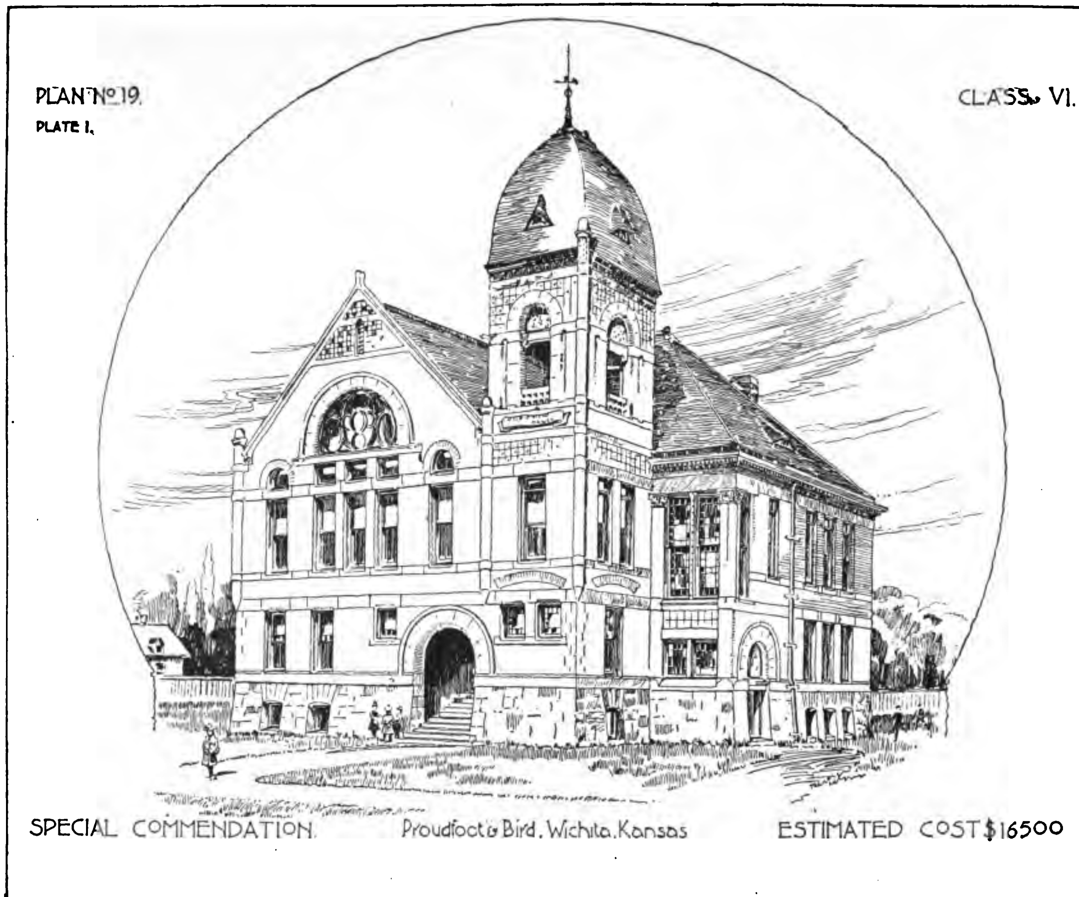

PLAN No 19.
PLATE I.
CLASS VI.
SPECIAL COMMENDATION.
Proudfoot & Bird, Wichita, Kansas
ESTIMATED COST $16500

Fig. 43.

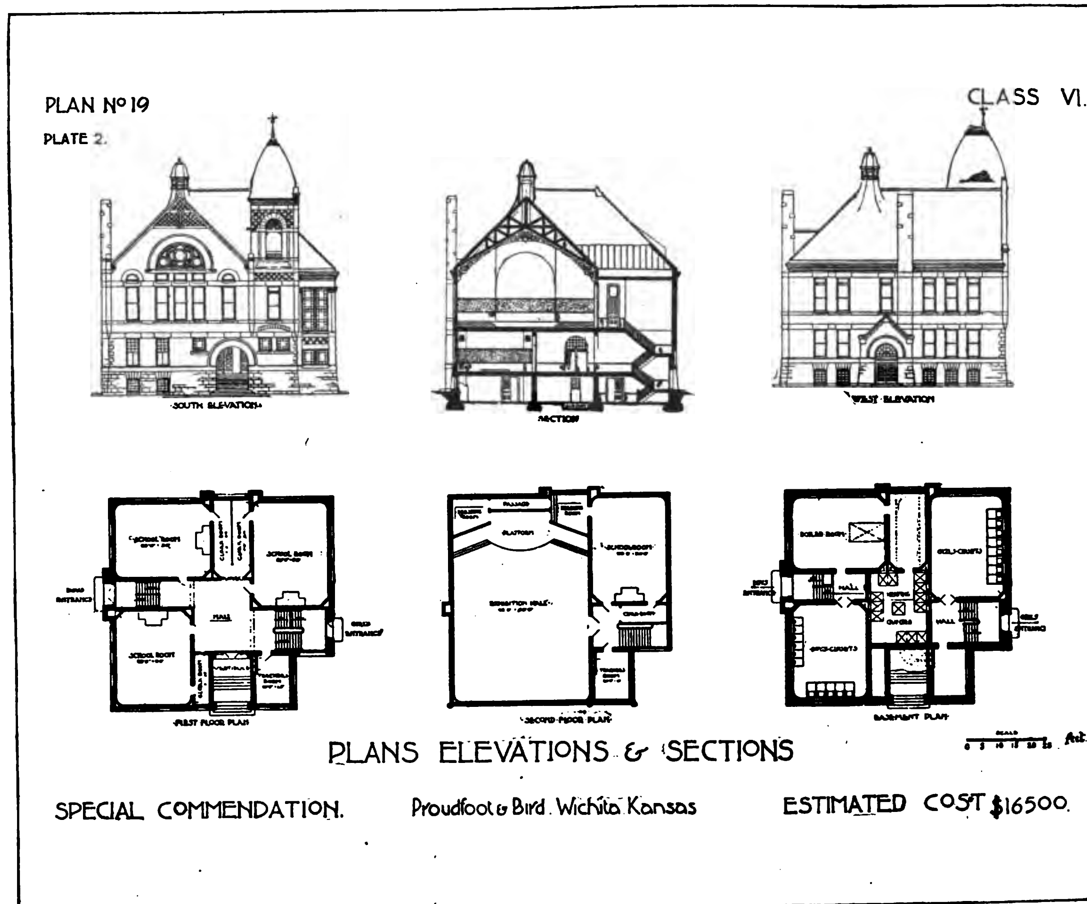

PLAN No 19
PLATE 2.
CLASS VI.
SOUTH ELEVATION
SECTION
WEST ELEVATION
FIRST FLOOR PLAN
SECOND FLOOR PLAN
BASEMENT PLAN
HALL
PLATFORM
PLANS ELEVATIONS & SECTIONS
SPECIAL COMMENDATION.
Proudfoot & Bird. Wichita. Kansas
ESTIMATED COST $16500.

Fig. 44.

FIG. 45.—Union Free-school building, Pelhamville, N. Y.

God watcheth the reapers
  That harvest His grain;
Soon He will reward you;—
  Joy! joy for your pain."

Hark! hark! 'T is the night-wind
  How welcome its song!
List! list to its teaching:
  "Peace cometh ere long.
Wait! labor with patience!
  Darkness soon will be past;
DAY dawn with great glory;
  Joy crown you at last."

THE NEW NORMAL SCHOOL BUILDING AT BRIDGEWATER.

PRINCIPAL ALBERT G. BOYDEN.

MASSACHUSETTS was the first state on this continent to establish normal schools for the training of teachers for her public schools.

The school at Bridgewater was one of the first three state normal schools in America. It was opened in September, 1840, and its first principal was Nicholas Tillinghast, a graduate of the United States Military Academy at West Point; a man admirably adapted to this pioneer work, whose strength of character, and untiring efforts for thirteen years established the school upon a broad, deep foundation.

Marshall Conant was the second principal, who continued the good work of his predecessor for seven years. He was then succeeded by the present principal who is now upon his thirty-second year in this service.

The first six years of its life the town of Bridgewater provided the school with a home in the town hall. In August, 1846, the school moved into a new building, the first one on this continent erected for a normal school, a plain edifice of the Tuscan order, 64 x 42 feet, two stories in height, constructed of wood and costing $8,000.

The growth of the school made it necessary to enlarge this building in 1861, again in 1871, and still again in 1881. At the

end of fifty years the school had outgrown all these enlargements and the new building shown by the cut above, a large and handsome edifice, was erected.

It is a massive structure eighty-six feet in front by one hundred eighty-seven feet in length, three stories in height above the basement, and stands on the westerly side of a square of three acres which is bounded by School, Summer, Grove, and Maple streets. It has a commanding position, eighty feet back from School street, on which it fronts, and faces north-east so that the sunlight comes into every room. It rests on a foundation of Quincy granite. The walls are faced with water-struck brick of a rich red color, and the limits of the stories are marked by bands of mottled, buff brick, capped with blue marble from West Rutland, Vermont. The architects, Messrs. Hartwell & Richardson, of Boston, have shown excellent taste in the design of the building, and the contractors, Darling Brothers, of Worcester, have constructed it in the most thorough manner.

The front entrance is through an open porch with three massive arches into an ample vestibule, from which stairways ascend on each side of the porch in cylindrical towers. A corridor, spanned by eight fine arches, extends through the middle of the entire length of the building to the southwest entrance. There is a third entrance into the corridor at the middle of the west side through an open porch. Stairways ascend from the western entrances to the attic, affording a safe egress from all parts of the building. The north half of the first floor is occupied by the ladies' cloak-room, gentlemen's coat-room, two rooms for the library, and a retiring room for the lady teachers and pupils.

The remainder of the first floor, including four large rooms with three smaller class-rooms adjoining, is devoted to the model school, composed of four primary grades and four grammar grades, and numbering one hundred and seventy-five pupils.

The basement story is one-half above ground, and a corridor extends lengthwise through the middle of it. It includes lunch-rooms for the students who come daily on the cars, and toilet rooms for the normal students; play rooms and toilet rooms for the model school; the fan room and the heating chamber, store-rooms, and the gymnasium 29 x 71 feet, with its dressing-rooms adjacent.

Ascending to the second floor, from the vestibule, are two passage ways leading to toilet rooms for the gentlemen and lady teachers, the principal's room, and the assembly hall, a beautiful room which extends entirely across the building, eighty-two feet in length, fifty feet in width, and seventeen feet in height, seating two hundred and fifty students. At the middle of the south side of the hall a double door opens into the corridor leading to the class-room for languages, four large laboratories for the natural sciences, two teachers' laboratories, an apparatus room, and the library for text-books.

The front stairways lead to a corridor extending lengthwise through the middle of the third floor. This floor includes, on the right, the principal's class-room, a double room for drawing, the two chemical laboratories, elementary and advanced, with the teacher's laboratory between; on the left, two class-rooms for mathematics, one for vocal culture and reading, the physical laboratory, and lecture room, with the teacher's laboratory between them.

The rooms are large, light, sunny, fitted with tables and chairs, drawers, cupboards, and cabinet cases, arranged in the best manner for practical work. The institution has large collections of working specimens, and cabinets of classified typical specimens for use in the daily work.

The building is heated and ventilated by the fan system. The air is driven into the rooms, and out through four large ventilating shafts. The rooms are kept at a uniform temperature by the Johnson heat regulator.

In the simplicity of its arrangement, its adaption to school wants, and in all its appointments it is a model building of which the state may justly be proud. Its cost is $150,000.

The school has a notable history, an able corps of instructors, and offers excellent advantages to men and women who desire training for the teacher's profession.

THE OLD AND THE NEW IN EDUCATION.

BY JESSIE M. ANDERSON.

Author of "Lessons for a First Year in English Grammar."

IN his essay on Culture, Emerson remarks that after visiting the Exhibition of the Industrious Fleas, the hardiest skeptic will be forced to belief in education. If the somewhat limited intellect of the brightest flea be measured against the mentality of the stupidest child you know, it will seem worth while to educate the child. And if you may expect a *proportionate* degree of gain, the result is quite incalculable.

But in these days and in this country, the question is a different one; not, Is general Education worth while? but, What direction shall it take?

Every one nowadays who talks about education at all asks what the Greeks did. Macaulay puts the answer into a short, vivid paragraph:

"Books, however, were the least part of the education of an Athenian citizen. Let us, for a moment, transport ourselves in thought, to that glorious city. Let us imagine that we are entering its gates, in the time of its power and glory. A crowd is assembled round a portico. All are gazing with delight at the entablature, for Phidias is putting up the frieze. We turn into another street; a rhapsodist is reciting there; men, women, children are thronging round him; the tears are running down their cheeks; their eyes are fixed; their very breath is still; for he is telling how Priam fell at the feet of Achilles, and kissed those hands, — of the terrible, — the murderous, — which had slain so many of his sons. We enter the public place; there is a ring of youths, all leaning forward, with sparkling eyes, and gestures of expectation. Socrates is pitted against the famous Atheist from Ionia, and has just brought him to a contradiction in terms. But we are interrupted. The herald is crying — 'Room for the Prytanes.' The general assembly is to meet. The people are swarming in on every side. Proclamation is made — 'Who wishes to speak!' There is a shout, and a clapping of hands; Pericles is mounting the stand. Then for a play of Sophocles; and away to sup with Aspasia. I know of no modern university which has so excellent a system of education."

Now its excellence lies in two points; its wideness of range, and its immediate interest; and the combined result is a wide-awake type of mind.

Accordingly it is not in the lack of books, that we are to copy the Greeks, or in any other circumstance which could not hinder but did not cause their success; nor is their only lesson for us, to bring physical culture into the foreground, as certain base-ball nines would have us imagine; but we must infuse into our educational life these two elements; we must make education liberal, and we must make it of immediate interest.

Practically these requirements are both met in the study of the questions of the day. The Athenian boy felt that he must help decide the questions of his day; and these were never mere matters of speculative criticism, but always of decisive taste and judgment. Not, Is this play, or this statue, justifiable on abstract principles of art? but, Shall we accept or reject it? Not simply, Is this oration good oratory? but, Will its proposed measures avert public calamity?

Our present questions are not less wide or less absorbing. But the attention of our youth is divided, and a large share necessarily given to work that is distinctly literary or abstractly critical.

Our plea now is just this: Let a fair share be given to the study of the latest thought and the latest attainment.

In the region of books, — our boys and girls must be trained to use the taste already cultivated by the best classical literature in the discriminating study of what our best modern writers are doing, — in poem or novel or magazine article. They must understand once for all that the new is not the old, and not an imitation of the old; they must see that the difference is vital; they must be trained to help on the tendency in it that is good, and to fight the tendency in it that is bad.

For instance, our fiction is depending less on plot and more on metaphysics. Here is a distinct tendency, on the one hand, to make morbid writers and morbid readers. We have the novel that depicts the heroine's spiritual struggle over a mood of the blues in the tragic colors of Aeschylus. Our young people should be educated to the point where they will put this book aside with voluntary disgust. The other side of the tendency is to displace the old thirst for royal pageants and masked knights by an interest in the every-day and trivial lives of commonplace people. Our youth must be trained to get this best thing out of modern fiction, and to enjoy Miss Alcott's *Little Women* and Mr. Howells' short stories for boys.

Again, our science is so changed from the old as to be almost a new factor. The literature of science has been wonderfully simplified, and there is hardly a department that does not offer books full of absorbing interest to boys and girls; from Miss Merriam's *Birds through an Opera Glass* to Prof. J. B. Clark's charming little work, *The Philosophy of Wealth*, which makes perfectly clear to an intelligent boy or girl of sixteen, the fundamental principles of that most complicated and abstruse chapter of science, political economy.

To enjoy these books and to be educated by them, our boy or girl must be trained to put down the book that makes the subject entertaining at the expense of truth or depth; and take keen pleasure in the one that develops his eye-sight and his ear-hearing and widens his thought. Such a boy or girl will have all the best qualities of the Athenian intellect; he will be awake to the pleasure given him to enjoy in his natural life, as he listens to the bird-songs or revels in the color of the worm or the form of the weed-blossom. He will have the Athenian interest in questions of state, for his political science will make him listen to his father's talk on the labor debate. And his geography and geology will inform him that the world is large around him and has been long before him.

In religion this recognition of what is good and what is bad in new movements is most important. The tendency to change is strongest here; the good must not be lost in rejecting the bad. The worst in the tendency is to do away with faith in the supernatural; the best in it is to simplify creeds and to make our religion clearer and more reverent, as scientific method clarifies our thought and reveals more fully the wonders of the supernatural.

Professor Drummond's address on The Greatest Thing in the World is the outcome of a religious reverence deepened by scientific research and simplified by scientific training.

But if we are to get the best out of Athenian culture, we must not neglect the more specific forms of artistic study; and no one can doubt the wisdom of introducing some of this training into every child's school-life.

The kindergartens are taking the early steps in this direction. They give the little ones a chance for developing their taste in combining colors, and their skill in using lines and curves; the children mould the soft clay into simple forms, and draw easy outlines or learn to produce light-and-shade effects with their bits of charcoal.

Sometimes in the higher schools the pupils are taught enough of the principles and practice of drawing and painting and modelling to appreciate a "finishing year" on the history of art; all this must give them some insight into the value of art-galleries and some correct appreciation of the best pictures and statues everywhere.

In a few schools a like training is offered in musical study. Beginning with the most simple reading and singing of well selected exercises, with frequent *musicales* — in which a good performer may play selections of the choicest classical piano-music or render vocal numbers, accompanying the exercise with short lectures and comments, — after a few years the result will be quite remarkable. A whole senior class, though only a few members have taken special courses in vocal or instrumental practice, will be found able to tell good music from bad; to appreciate the best qualities of the music and of its rendition in a good recital.

In the more strictly technical parts of education, there is no tendency to neglect current methods. The farmer has his new combination cutter, reaper, and binder, and the census-maker has a slot-machine. The typewriter and the reporter are not often an hour "behind the times."

Everything that is new seems to be trying to "break the record" in point of time; and in these days, of those two mottoes that used to hang on the walls that surrounded our early educational processes, KNOWLEDGE IS POWER has fallen face downward to the floor; while its rival, TIME IS MONEY holds sway over every ambition. But only when some sort of balancing is effected between these opposite forces, will education — conservative in what is good and progressive in what is good — become symmetrical.

VON ASBETH ON THE CLASSICAL QUESTION.

SPEECH IN THE HUNGARIAN DIET, BUDAPEST.

(Translated from the German in Pædagogium.)

BY D. LANGE, ST. PAUL.

IF educators throw the study of Greek, that is, the ancients themselves out of the Mittelschule,* which means out of the national education, then they rob the nation of something which no other study can supply.

Then at a time in which even religious ideas are shaken, there will arise a generation that has lost all connection with the past, a generation that will deem it useless to inquire where their grandfathers were buried, and will much less care to know for what they lived or died.

A generation will spring up, gentlemen, who, from the lofty height of their enlightenment, will look down with pity and disdain upon the antiquated prejudices of their ancestors. And with strictly logical sequence, this generation must sooner or later arrive at the conclusion that reverence for parents can rightly be demanded only as long as parents are directly useful. Thus will come into existence a society that is indifferent alike to the past and the future, a society whose only ideal will be pleasure, ease, and "pocketable" gain.

And when this Americanism, this western materialism and greed of gain, without the feverish activity of the West joins hands with Oriental indolence without the frugality and contentment of the East, as would happen here; then, gentlemen, nothing but a degenerate race can be the result of this connection, but never a nation.

The Hungarians, gentlemen, in accordance with their number and proud spirit, will not stoop to play any other role but that of

* By Mittelschule are understood the Gymnasium, the Realschule, and similar institutions.

a nation. It is my conviction that Hungary would make a most serious mistake to imagine that she would be able to exist as a state of second or third rate, not minding her neighbors and not being minded or disturbed by her neighbors. It would be impossible for us, taking into consideration our geographical and ethnographical position and our comparatively small numbers, to maintain an independent state in this part of Europe where we are forced to live and die. A so-called neutral middle state has never been able to exist for any length of time in southeastern Europe. Hungarians will either occupy a fitting position in a large empire upheld by themselves, or they will become merely a suppressed and insignificant nationality. Intellectual excellence only, the greatest exertion put forth in this direction, can counterbalance our inferiority in numbers.

But with this mission, gentlemen, it does by no means agree that we exclude from our national education those studies in which intellectual excellence shines forth most splendidly, which teach the knowledge of the human heart and the human soul, the progress and destiny of man to a degree never attained by other subjects.

Gentlemen, we need not underrate our own time. This age, with its technical achievements, with its inventions which from day to day revolutionize our mode of life, calls forth our admiration. This age deserves indeed to be called great on account of its irresistible energy and activity. But it is evident that an age of electricity, of overland flyers, of "Zonetariffs," of the nerve-attacking telephone, cannot be a time of intellectual concentration. It cannot be a favorable age for harmonious contemplation on man and the world in general. The ancients, on account of their far more simple conditions of life, were in a far better position to reflect and meditate on man himself. This is the reason why the fountains of wisdom, of law and art are principally found in Greek civilization, beside which even the Romans present only an imitation, a second-hand civilization. Even our material development draws on these treasures today. I grant that we have gained much new information and gain more every day, but scarcely have we evolved any new ideas. Through this intellectual concentration the history, the law, and the arts of the Greeks became so instructive, so sublime, through this the understanding of man's heart and soul grew so deep and true. All this, however, can only be assimilated as long as the battle of life has not disqualified us for receiving deep impressions. In later life harmonious mental concentration becomes impossible. After the strong passions of youth have arisen, when the battle for existence must be fought, after the daily routine of two times two is four, after the coarse prose of cash gain have entered a man's life; then it is too late to assimilate all this. And even if one were to attempt it, yet it would only be done with much greater labor, exertion and loss of time, or only through the medium of stale, insufficient translations.

Finally, gentlemen, to say that the mental exertion is too much for us Hungarians, that, gentlemen, is a downright pernicious argument, an argument nipping national ambition in the bud. That would not be the proclamation of intellectual vigor, but of intellectual inferiority; it would not only be abandoning the mission to lead others, it would be surrendering our place among civilized nations.

THE RISE OF MATHEMATICS IN THE UNITED STATES.

BY PROF. FLORIAN CAJORI, COLORADO SPRINGS, COL.

THE success attained during the last fifteen years in the study of higher mathematics in the United States adds general interest to a survey of the path of ascent to the present elevated position occupied by American mathematicians. This ascent has been a slow one. During the years past the genius of the American people was exercised mainly in achieving material progress and the cultivation of pure science was neglected.

That mathematics did not flourish during colonial times is not surprising. When Harvard College was founded, in 1636, mathematical research in Europe was fostered by such master-minds as Cavalieri, Torricelli, Pascal, Fermat, Roberval, Descartes, and Wallis, but as yet it had hardly reached the universities of Europe. In Cambridge, England, "there were no mathematical studies at all at that time . . . and none to give even so much as advice what books to read." Need we marvel that Cambridge in New England was not mathematical from the start? The fountain could not rise higher than its source. It must be remembered, moreover, that since the prime object of Harvard and other American colleges was to train young men for the ministry, much attention was given to ancient languages and metaphysics, while mathematics was neglected. Thus, before the middle of the eighteenth century, no mathematics whatever was required for admission to Harvard and Yale, nor was it studied except during the last year of the college course, when the budding theologians did homage to the mathematical science by the study of arithmetic, elementary geometry (consisting chiefly of a course in surveying) and a little astronomy. Some time before 1750, mathematics was, at least, dethroned from its august position as a senior study and assigned an humbler place at the beginning of the college course. No mathematics whatever was required for admission at Harvard until 1803. At that time students began to be examined in arithmetic "to the Rule of Three." In most other colleges this requirement began to be made at a much later date.

Algebra was an unknown science in America during early colonial days. It appears to have been introduced at Yale in 1742 and at Harvard at about the same time. But at a still earlier date (on or before 1724) it appeared in the course at William and Mary College in Williamsburg, Virginia. Favorite text-books in New England colleges from about 1700 to about 1776 were Alsted's Geometry, Euclid's Geometry, and John Ward's Mathematics. All these books were imported. The era for the writing and printing of college text-books in the United States had not yet begun.

Newtonian ideas were slow in finding their way into the new world. To be sure, at Yale that young and progressive tutor, Samuel Johnson (afterwards president of King's, now Columbia college) taught the Newtonian doctrines between the years 1715 and 1722. He mastered them from a copy of Newton's Principia which was in a collection of books made in England for the college, and which furnished him with a "feast of fat things." Soon after the departure of Johnson, a retrograde step was taken by the adoption at Yale of the Physics of Rohault, a follower of Descartes. The edition used was that of Samuel Clark, an Englishman who added numerous notes with a view of bringing the Cartesian system into disrepute by exposing its fallacies. The same work was used at the university of Cambridge, England. At Harvard, Gassendi's astronomy was used in 1726. Thus, forty years after the publication of Newton's Principia, an astronomy was used in Harvard, the author of which died before the name of Newton had become known to science. In 1743 the complete victory of Newtonian ideas at Yale (and at about the same time at Harvard) is seen in the adoption of Gravesande's Philosophy as a text-book.

During colonial times no original work was done in this country in pure mathematics, but some interest was shown in astronomy. The most distinguished astronomer of this period was David Rittenhouse of Germantown, Pa. He was entirely self-taught and one of the very few men of his time who pursued science out of pure love for it. On the third of June, 1769, he observed the transit of Venus in a temporary observatory constructed by himself, and he took notice of one phenomenon which escaped the attention of everybody else; namely, when the planet had advanced about one-half of its diameter upon the sun, that part of the edge of the planet which was off the sun's disc appeared illuminated, so that the outline of the entire planet could be seen. That proves that Venus has an atmosphere. This observation of Rittenhouse excited no attention for nearly a century, until it was at last confirmed by other astronomers. Rittenhouse was celebrated for the wonderful orreries which he constructed.

The progress of mathematics since 1776 may be divided into two periods, the Influx of English mathematics and the Influx of French mathematics. With the first period began the writing and printing of mathematical books among us. The number of arithmetics alone, printed before 1820, exceeded sixty. Many books were reprints of English works. All American compilations were modelled after English patterns. The English algebras of John Bonnycastle and Thomas Simpson, Robert Simson's and Playfair's editions of Euclid, Vince's Fluxions, and Hutton's mathematics were books found in libraries of American professors. The English are thus seen to have been our teachers, although they themselves were then far behind the mathematicians of the European continent.

The first American who compiled a course of mathematics for colleges was Samuel Webber (1801), professor at Harvard. In 1814 Jeremiah Day of Yale began the publication of a popular mathematical series. These series did not include fluxions. Occasionally students advanced far enough to enter upon the elements of that subject, but this was of rare occurrence. During this period, mathematical instruction was still very inferior in quality. As a rule pupils took no interest in mathematical studies. The professors themselves never felt the glow of a new idea and were, often, quite incompetent. The text-books taught rules rather than principles.

In 1804 was started the *Mathematical Correspondent*, the earliest mathematical journal in this country. Like several other periodicals which sprang into existence soon after, it had only a short life. These periodicals were devoted almost exclusively to the solution of elementary problems and were, therefore, of merely educational value. Nothing in them added to the stock of mathematical knowledge, excepting a paper by Robert Adrain in No. IV. of the *Analyst*, containing deductions of the Law of Probability of Error in Observations. This law was first stated in printed form by Legendre in 1806, but Adrain, working independently of Legendre, was the first to publish proofs of this law, of which he gave two. Until recently Adrain's work was quite unknown.

The most distinguished mathematician of this time was Nathaniel Bowditch. Like David Rittenhouse, he was never in college either as teacher or pupil, but was wholly self-taught. He may fitly be called the morning-star of American mathematics. With him began a new epoch, the influx of French mathematics. Trained in the school of poverty, possessed of indomitable energy, he mastered, while on long sea-voyages as a sailor, one branch of mathematics after another. Later in life he was an officer of insurance companies. He was the first American to study French works. In 1801 he published his "Practical Navigator" and in 1829 began the publication of his translation and commentary of Laplace's Méchanique Céleste. At this time French and Swiss authors came into ascendency among us. Professor Farrar of Harvard translated Lacroix's Algebra, prepared an introduction to the elements of algebra selected from the algebra of Euler, translated Legendre's geometry, Lacroix's Trigonometry and Bezout's Differential and Integral Calculus. These books appeared bebetween 1818 and 1824. At this time Euclid came to be discarded almost everywhere in favor of Legendre or similar works. In the United States Military Academy at West Point, the most prominent professors were French and Swiss, or Americans who had studied in France. The course of study at that institution was modelled somewhat after the courses at the Polytechnic school in Paris. The United States Military Academy was, during this period, the most influential mathematical school in the country.

The period of the influx of French mathematics, which began about 1820, was a bright one as compared with the preceding. Mathematical journals now occupied a higher level of merit. Marked improvements were made in the text-books and in methods of teaching. Pestalozzian ideas found their way into elementary schools. The introduction of the black-board doubled the instructor's power of teaching. The government established the United States Coast Survey, of which Ferdinand Hassler, trained in the niceties of this line in Switzerland, was first superintendent. This work has been carried on with a high degree of efficiency under Alexander Bache and the later superintendents. An astronomical observatory was founded by the government in Washington in 1842. Before this time Congress had repeatedly refused an appropriation for an observatory. Once President J. Q. Adams, in one of his messages, urged this matter upon Congress, saying that in Europe there were "upward of 130 light-houses of the skies," while in America there was not one. His eloquent appeal was received with a torrent of ridicule; and the scheme to establish a light-house in the skies became a common by-word of reproach. It need hardly be said here that in later years the United States government has been very liberal in the aid of science.

Notwithstanding this progress in various directions, the achievements were small indeed as compared to those of European countries. Ours was not the glory of the sun, but of the moon. we imitated the French in some of their text-books, but we failed to catch their enthusiasm and to display originality of thought. The only really prominent mathematician of this period was Benjamin Peirce, professor at Harvard (died 1880). Professor Arthur Cayley calls him the father of American mathematics. His text-books for colleges were concise and elegant, and so full of novelties that they never became widely popular. A much wider circulation was enjoyed by the works of Charles Davies and Elias Loomis. Peirce's Analytical Mechanics is an advanced work of much merit. His memoir on Linear Associative Algebra secures for him lasting fame. It is by far the most important original contribution to pure mathematics made in this country. Peirce did much work in mathematical astronomy. Distinguished in this line were also William Chauvenet, the author of a Spherical and Practical Astronomy, of a Trigonometry, and of an elementary geometry (all excellent works), — and James C. Watson, author of a Theoretical Astronomy.

It was a fortunate circumstance for the progress of mathematics in the United States that when Benjamin Peirce was near his grave, there came to our shores an eminent mathematician to give new impetus to mathematical studies. This man was Prof. James Joseph Sylvester, who in 1876 came to the Johns Hopkins university in Baltimore, and during his seven years' stay there, by his genius and enthusiasm, inspired young men for the study of advanced mathematics. He was the first editor of the American Journal of Mathematics, the first periodical of its kind among us, which is devoted to higher mathematics exclusively. Sylvester may be said to have inaugurated a new epoch in the progress of mathematics in this country. The number of men engaged in the study of advanced mathematics at the present time is far greater than it was at any previous period, and it can now no longer be said, as was said, that but a single important original contribution to pure mathematics has been made in America.

EDITORIAL.

WE are sure our readers will enjoy the feast of fat things which we are privileged to lay before them this month. Such writers as Edward Everett Hale, General Butler, Rev. Wm. M. Thayer, and Principal Boyden need no introduction to any American audience. The other writers in this number, while less widely known, are all able to interest and instruct.

SOME of our readers have already availed themselves of our offer to send EDUCATION two years *free*, or advance their dates of subscription *two years*, on receiving a cash order for that choice set of volumes — the "Library of American Literature." Turn to the Bulletin Board and read our offer.

GEN. BENJ. F. BUTLER, — from whose forthcoming autobiography we are permitted, by the courtesy of the publisher, to publish an article — has long been a conspicuous figure. Few living men have as many warm friends or more bitter opponents. He has never done things by halves. Whether men love him, or hate him, they will read his book, — which will appear the last of this month, — with absorbing interest. Of the friends of Butler among the warmest are the negroes of Virginia. With many of them he holds a place higher even than that accorded to Abraham Lincoln. Gen. S. C. Armstrong of the Hampton Institute, in a letter which we have just had the pleasure of reading vouches for the following: Preparatory to Hampton Institute is the "John G. Whittier school" in which three hundred colored children gather daily from the neighborhood. One day General Armstrong went in and began quizzing them: "Children! who freed the colored people?" Up went the little dusky hands. "Well?" "Ben Butler." "Who was the Father of his Country?" "Ben Butler!" "Who never told a lie?" Answer, in full chorus, "Ben Butler!"

LAST summer for the first time in the history of university work, the University of the City of New York conferred pedagogical degrees; fourteen graduates receiving the degree of Doctor of Pedagogy, and twelve that of Master of Pedagogy. The average age of the doctor's class was over fifty years, but all had been faithful students of educational science for four years and had amply earned the honorable distinction they received. No class ever graduated from any university since time began, the average age of whose members was so great as this. Most of the members of both of these classes are principals or heads of departments in New York and surrounding cities. Since the commencement of lectures on pedagogy, four years ago, more than five hundred teachers have been in attendance; a School of Pedagogy has been organized and endowed as a department of University work; a definite course of study marked out, a good library commenced, free text-books pledged, and definite degrees promised. Education is now recognized as equal in professional rank to law, medicine, and theology. Lectures are given five days each week at four o'clock, and on Saturdays at ten o'clock from October to May, to accommodate those engaged in teaching. This is an auspicious omen for the future of pedagogy.

EDUCATION receives a great many warm words of praise. We seldom publish any of these as we think the magazine is abundantly able to stand on its own merits. But perhaps we may be pardoned for quoting the following from the Boston *Transcript* of Oct. 17, 1891, concerning the last number: —

"Larkin Dunton, LL.D., contributes Part V of his admirable, and what will undoubtedly prove a standard work on "Moral Education." "The Woman Problem," by Elizabeth Porter Gould, is suggestive and to the point. Though brief, it contains much valuable information,